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Technology Development Branch

Section de développement de technologies

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PROGRAM AREA: COMPUTER CONTROL OF BIOLOGICAL TREATMENT PROCESSES

PROJECT 68106: OPERATIONAL WASTEWATER TREATMENT PLANT MODELLING

PROJECT MGR: G. SPEIRS **TEL:** (416)336-4745

OBJECTIVE:

To develop and validate simple biological wastewater treatment models to be used for real-time operation and control.

RELEVANCE:

Municipal and industrial wastewater treatment plants are subject to changes in environmental conditions and transients in hydraulic, organic, and toxic loads which cause excursions in effluent quality. Simulations with dynamic models of wastewater treatment plants enable operators to evaluate and verify control strategies before implementation. However, existing models, such as the one developed by the IAWPRC, are generally unsuitable for use in operating treatment plants. Because of the number and type of variables contained in the models, model coefficients cannot be estimated from actual data collected from treatment plants.

Improved performance of wastewater treatment plants requires the development of simplified models which achieve a balance between a description of fundamental biological, chemical, and physical mechanisms and the ability to calibrate the model using treatment plant data. Research is proposed to develop such simplified models. Also, it is proposed to develop an expert system based on the extraction of operating rules from the simplified dynamic models.

WORK PLAN:

1) Review the existing work completed in this field to date.

2) Define a research program for further development, calibration, verification and demonstration of acceptable simplified models at both pilot and full scale.

STATUS REPORT - June 1990

The first of a series of technology transfer seminars by Dr. I. Takacs, Dr. G. Patry, and Dr. P. Dold was held at McMaster on May 28. The purpose of the seminar was to familiarize WTC personnel with the use and potential applications of the General Purpose Simulator (GPS). The information received will be incorporated by the Wastewater Technology Centre and McMaster into the research program to identify additional potential applications, further develop, calibrate, verify, and demonstrate this tool.

The GPS was used to assess the impact of flow reduction programmes on the performance of wastewater treatment plants. The GPS was calibrated to a nine-month set of data from the Saint Hyacinthe WTP. This was a very involved process which required a combination of techniques to identify a set of model parameters that would replicate the statistics of interest.

The GPS was then used to assess the impact of flow reduction goals of 10, 20, 30 and 40% using the data base. The organic loading (mass loading) was held constant and simulations were conducted over the same nine-month period of record. Probability plots were generated to show the impact on various plant operating and performance variables. One important result from this work was the identification that long term continuous simulation calibration needs to be handled differently than event-based calibration. Other alternatives are being examined to speed up the calibration process.

McMaster staff reviewed with G. Speirs and M. Hribljan the utility of the PC-based dynamic model simulation package for the optimization work at the Banff WPCP .

STATUS REPORT - September 1990

In support of various sewage treatment facility optimization studies, the General Purpose Simulator (GPS) was configured to a number of treatment plants, on a preliminary basis, to facilitate the utilization of process data for ongoing calibration, verification and simulation work.

The GPS was used to apply dynamic modelling to the Regional Municipality of Hamilton-Wentworth's Woodward Ave. sewage treatment plant (STP) for the preliminary assessment of the effect of step feed process control strategies on the handling of storm flows in the plant. A theoretical evaluation of the impact on overall plant performance, with and without step feed control capability, that would result from improving the performance of the "old plant" clarifiers to the level consistently achieved by the "new plant" clarifiers was initiated. The incorporation of operating data from the plant to calibrate/verify the models for simulation purposes was initiated.

The Port Colborne SeaWay STP was configured into the GPS to facilitate better use of process data obtained from a plant audit currently underway. This application is designed to examine the feasibility of using the GPS as part of a comprehensive planning analysis for optimizing plant operation and utilization.

Preliminary modelling of the Lille-Marquette, France STP using the GPS led to additional discussions with Lyonaisse des Eaux regarding further research activities with the GPS and technology transfer.

A proposal for incorporating the GPS in an operational/process audit being considered for the Highland Creek wastewater treatment plant was prepared in response to interest in the modelling technology from Metro Toronto.

Discussions with DND have been initiated regarding the utilization of the GPS as part of a process audit for the CFB Trenton STP. It is envisioned that ultimately DND could utilize the GPS as a training tool for staff responsible for operation of STPs at bases across Canada.

The progressive transfer of all software from the SUN 3/160 to the SUN 4/490 hardware is underway to improve the turn around in the calibration/verification simulation runs. Discussions continued regarding optimal transfer of the SUN 3/160 hardware and expertise in its utilization for GPS-related modelling activities to WTC personnel.

Dr. G. Patry presented two papers at the 5th IAWPRC Workshop on Instrumentation, Control and Automation of Water and Wastewater Treatment and Transport Systems held in Kyoto July 26-August 3. One presentation focussed on the use of the GPS in the simulation of

activated sludge plants, while the other was a poster presentation on the dynamics of *solid/liquid separation.

PROGRAM AREA: COMPUTER CONTROL OF BIOLOGICAL TREATMENT PROCESSES

PROJECT 68112: OPTIMIZATION OF AUTOMATED SYSTEMS FOR FULL-SCALE ACTIVATED SLUDGE TREATMENT FACILITIES

PROJECT MGR: G. SPEIRS **TEL:** (416)336-4745

OBJECTIVE:

To determine and demonstrate optimum control strategies for automated process control systems to maximize aeration energy savings and plant throughput capacity while meeting performance and reliability criteria.

RELEVANCE:

Energy savings of 15 to 35 percent and improved process control through the automated control of dissolved oxygen concentration and biological solids inventory has been demonstrated by the WTC at pilot scale and more recently at the Tillsonburg, Ontario STP. The incorporation of automated control strategies can also optimize the capacity of existing facilities and postpone unnecessary plant expansions, thereby saving potential capital expenses.

WORK PLAN:

1) Complete the documentation and report preparation of the Tillsonburg project results.

2) Determine the long term monitoring and control needs of the Tillsonburg, Ontario plant staff, and to identify an appropriate instrumentation and control system that may be left in place.

STATUS REPORT - June 1990

Final draft preparation and editing of the project report for EPA are near completion. Will be forwarded next month.

Additional inhouse discussions were held regarding decommissioning of the project and transfer/handback of total operation of the Tillsonburg plant to the MOE. Meetings with the MOE plant staff and regional office will be held upon completion and delivery of final report to the EPA. WTC continued to maintain the I & C system at the plant.

STATUS REPORT - September 1990

The draft Final Report for the Tillsonburg demonstration project was submitted to U.S. EPA for review. A presentation on the program results was presented by Dr. H. Melcer at the 5th IAWPRC Workshop on Instrumentation, Control and Automation of Water and Wastewater Treatment and Transport Systems in Kyoto, Japan July 26 - August 3.

Meetings with the Ontario Ministry of the Environment to discuss transfer of hardware and total operation of the Tillsonburg STP are scheduled for the next quarter. WTC personnel have continued liaise with plant operations staff to ensure that data acquisition and control have been maintained during this transition period.

PROGRAM AREA: **COMPUTER CONTROL OF BIOLOGICAL TREATMENT PROCESSES**

PROJECT 68118: **TECHNICAL SUPPORT FOR PROCESS/OPERATIONAL AUDITS FOR OPTIMIZING BIOLOGICAL WASTEWATER TREATMENT FACILITIES**

PROJECT MGR: **G. SPEERS** **TEL: (416)336-4745**

OBJECTIVE:

To promote and facilitate the utilization of technology developed by the WTC for the optimization of biological wastewater treatment systems in both the municipal and industrial sectors.

RELEVANCE:

Currently, a major focus on improving receiving water quality is the requirement of point source dischargers to meet ever-increasingly more stringent effluent quality standards. Traditionally, and especially when government program funding is made available, the response to this type of initiative has been the "identification" of a need for extensive capital investment at wastewater treatment facilities for plant expansion to accommodate "necessary" process upgrades. Often, such investment is misplaced in that the evaluation of the existing facility is incomplete or inadequate, and total advantage of the existing processes and infrastructure is not fully realized.

The WTC has developed and demonstrated the use of enhanced process and operations auditing techniques to obtain the data necessary to thoroughly evaluate, optimize performance, and determine the true capacity of existing wastewater treatment systems. This assessment includes a cost-benefit analysis of incorporating appropriate state-of-the-art, instrument-based data acquisition and control strategies for improved plant performance. A further benefit of conducting such in-depth, site specific evaluations is that where process upgrades or expansion are deemed necessary, the data obtained as part of the audit provides critical information upon which the design must be based. Therefore, it is extremely critical that this technology be used before the design of any anticipated facility expansion and process upgrade is undertaken to ensure the most cost-effective process optimization in terms of plant capacity, effluent quality, operational requirements and energy use is achieved.

WORKPLAN:

1) To facilitate, implement and direct the use of enhanced process/operational audits at selected treatment facilities.

2) To facilitate the continual improvement and development of the process/operations audit technology. This will include the incorporation of the General Purpose Simulator for model utilization and simulation.

STATUS REPORT - September 1990

CH2M-Hill Engineering Ltd. was awarded a contract to conduct an enhanced, computerized process/operations audit of the Burlington Skyway STP in support of the Great Lakes Program Hamilton Remedial Action Plan (RAP) initiative. A steering committee for the project

assembled to monitor and review the results of the audit met in July to review the terms of reference and project initiatives. Members include personnel from the R.M. of Halton, Ontario Ministry of the Environment, Ontario Hydro, R. M. of Hamilton-Wentworth. XCG Consultants have been retained to provide contract management services to the WTC for this project. The consultant initiated a review of historical operating and performance data and the installation of on-line instrumentation and data acquisition equipment.

Preliminary discussions were held with R.M. of Hamilton-Wentworth regarding the implementation of a process/operations audit of the Woodward Ave. STP in support of the Hamilton RAP. Similar discussions were initiated with the Town of Collingwood in support of the Collingwood Harbour RAP and with Metro Toronto regarding the Highland Creek STP.

A site visit was made to CFB Trenton to review STP performance and operating status. Preliminary discussions have been initiated regarding the practicality of undertaking an operational audit of the facility.

PROGRAM AREA: COMPUTER CONTROL OF BIOLOGICAL TREATMENT PROCESSES

PROJECT 68117: OPTIMIZATION OF INTEGRATED CONTROL STRATEGIES FOR LIQUID AND SOLIDS HANDLING PROCESSES IN BIOLOGICAL WASTEWATER TREATMENT

PROJECT MGR: G. SPEIRS **TEL:** (416)336-4745

OBJECTIVE:

1) To determine optimum control strategies for individual solids and sludge handling unit processes, and to integrate them with effective liquid train control strategies for overall optimization of the activated sludge treatment process.

2) To demonstrate how state-of-the-art treatment processes and control strategies can be incorporated to achieve the most cost-effective wastewater treatment plant design and operation.

RELEVANCE:

The interaction and impact of liquid train process control strategies on the solids/sludge production and handling unit operations has not been investigated to date. These unit operations are energy and cost intensive and it is important to determine not only optimum control strategies for the individual sludge handling unit operations, but also the correct coupling of liquid and solid train management strategies to achieve overall plant optimization in terms of capital expenditures, and process performance and efficiency.,

WORK PLAN:

1) Identify the appropriate automated control strategies for the liquid train at the Banff, Alberta STP to achieve cost-efficient operation and consistently meet plant effluent quality requirements.

2) Investigate fundamental operating considerations for the individual unit processes of the sludge handling train at the Banff, Alberta STP as part of a longer term goal of overall plant optimization.

STATUS REPORT - June 1990

Significant changes in the operation of the Banff STP were initiated to help minimize problems with sludge bulking due to filamentous organism growth, algae accumulation, and sludge age control. The use of the lagoon for day to day flow balancing was discontinued as it had become the source of extensive algae accumulation in the plant. In addition, the return of supernatant from the digester to the lagoon was discontinued. Chlorination of the RAS line for sludge bulking control was discontinued as the plant operation improved and its effluent compliance criteria was consistently maintained.

Control algorithms have been modified and instrument calibration confirmation and, in some instances, relocation of sensors initiated. As the plant is still under warranty, this work has been delayed because of the need to coordinate and liaise with the contractor/sub-contractor/suppliers.

A preliminary work plan was developed identifying the activities and approach to optimize the operation of the individual unit processes. Work has been initiated with Dr. P. Dold, Dr. I. Takacs, Dr. G. Patry of McMaster University and M. Hribljan of Aquatrol Technologies to incorporate the General Purpose Simulator in these research and optimization activities.

STATUS REPORT - September 1990

Improved control of the liquid train operation at the Banff STP resulted in the discharge of a consistent, high quality final effluent. The operation of the sludge processing train was also stabilized. However, despite these improvements in overall performance, excessive odour emission from the plant was reported on a routine basis during July and August.

It was determined that the flow equalization lagoon was the major source of these odours. Although use of the lagoon had been discontinued in June, except on an emergency basis, its extensive use during the spring and early summer to help mitigate process upsets had resulted in the retention of a high liquid level and a significant solids inventory. The resulting anaerobic conditions combined with the onset of warm weather led to a "turnover" of the lagoon contents and the ongoing expression of significant odours. Improved handling of the internal recycle streams and more stable operation of the liquid train allowed for the return of the lagoon contents to the plant for treatment. By the end of the quarter, the level of the lagoon was reduced to its minimum and odour complaints greatly reduced. Options for further treatment of the lagoon contents are under review.

The sludge handling train was identified as the other major source of odours. Improved process control and maintenance of the autothermal thermophilic aerobic digestion process and its offgas scrubber system have helped to mitigate odour emission. Odour masking agents have also been tried with success on the sludge dewatering stage. However, given the location in very sensitive surrounding environs, further investigation is underway to ensure that overall odour production is minimized.

Meetings were held between representatives of U.S. EPA, McMaster University, Reid Crowther & Partners Ltd. and WTC to develop the basis of research for fully optimizing the liquid and solids handling process trains. This action is ongoing.

PROGRAM AREA: TRACE CONTAMINANT CONTROL

PROJECT 68103: FATE OF TRACE CONTAMINANTS IN BIOLOGICAL TREATMENT SYSTEMS

PROJECT MGR: H. Melcer **TEL: (416)336-4546**

OBJECTIVE:

To determine the effectiveness of biological process technologies in removing trace contaminants from wastewaters.

RELEVANCE:

Increased pressure for toxic chemicals control has generated considerable information on the control of specific contaminants such as the Ontario EMPPL compounds, the U.S. EPA priority pollutants, chlorinated compounds and complex nitrogenous materials. Increasing evidence in the literature and from in-house work shows that biological systems are capable of achieving high levels of contaminant control.

This work responds to the requirements of the Technology Development Branch toxic chemical control, and supports the Industrial Programs Branch needs in developing codes of practice for the control of trace contaminants in the municipal and industrial sectors.

WORK PLAN:

1) Work will be initiated to demonstrate the effect of SRT control on the removal of specific organic contaminants.

2) Technical support will be provided to the Ontario Ministry of the Environment in the development of their MISA program on an as required basis.

STATUS REPORT - June 1990

Considerable effort has been spent in trying to identify the disparity in VOC mass balances between parent compound and C14-labelled compound analyses. The worst instances were 300% recoveries for chloroform and trichloroethylene. Analytical and sampling protocols have been reviewed, overhauled and substituted where deemed appropriate without solving this anomaly. It is intended to discuss this issue with the peer review group at the next scheduled meeting.

STATUS REPORT - September 1990

Improved procedures for contaminant delivery and sampling were installed in the laboratory systems. A direct injection syringe pump was purchased. Following trials with acceptable recovery of C14-labelled VOCs, a further two syringe pumps were ordered for the remaining activated sludge units.

Collection of VOC vapours was evaluated using Tenax traps in place of Tedlar bags. Repeated experiments with stripping of chloroform and trichlorethylene from water solutions showed recoveries of 102 - 110%.

Following these modifications, a revised experimental plan to investigate the fate of VOCs in activated sludge systems has been initiated.

PROJECT 68104: **MODELLING OF CONTAMINANT REMOVAL BY ACTIVATED SLUDGE SYSTEMS**

PROJECT MGR: **H. Melcer** **TEL: (416)336-4546**

OBJECTIVE:

To develop a PC computer-based model to forecast the removal of trace organic contaminants by activated sludge systems.

RELEVANCE:

With the development of regulatory programs for the control of toxic trace contaminant emissions from municipal wastewater treatment plants, there is an increasing need for tools that forecast the ability of these plants to remove the contaminants that are introduced into the municipal sewer system. With such tools, regulators will be better able to implement a sewer use control program which will ensure that treated effluent quality is maintained at the desired level while simultaneously protecting the viability of the biological treatment entity. This work is in support of the Ontario MISA program.

WORK PLAN:

The project will focus on the Ontario MISA EMPPL compounds.

1) Candidate compounds will be selected for assessment of physical and chemical characteristics.

2) Laboratory and pilot scale experiments will be carried out to provide data that are not available in the literature.

3) Predictive models will be developed based on these data and the results of ongoing studies at the WTC.

4) Field scale verification of the model will be carried out for some wastewater treatment unit operations.

STATUS REPORT - June 1990

An interim project report has been prepared which summarizes the work carried out on the fate of heavy metals, VOCs and chlorinated phenolics to date. Considerable progress has been made on extending the data base for the above groups of chemicals and also for selected pesticides and herbicides. Work continued on the development of computer software to accommodate changes in model structure. Both steady state and dynamic model equations have been modified and tested in the computer software.

STATUS REPORT - September 1990

New model equations were developed accounting for metal precipitation in the organic matrices typically found in sewages. The peer review panel suggested further model

improvements. Batch experiments with the candidate metals were carried out to verify the panel's suggestions. The panel also recommended modified statistical techniques to improve parameter estimates of biodegradation rate coefficients. Additional changes were made to the model to improve user friendliness and correct minor problems identified by the panel.

A copy of the model was submitted to Michigan Technical University researchers who were contracted by the WPCF Research Foundation to evaluate the integrity of toxic contaminants in sewage treatment plants.

A proposal to measure the removal of candidate toxic contaminants across the Burlington Skyway STP was approved by the Great Lakes RAP program. Data from this work will be used to calibrate the Toxchem model.

PROJECT 68129: PULP AND PAPER WASTEWATER TREATMENT

PROJECT MGR: E.R. Hall TEL: (416) 336-4715

OBJECTIVE:

1) To define and demonstrate "best available treatment technology for conventional and non-conventional pollutants in pulp and paper wastewaters, as required by federal and provincial agencies for regulations development.

2) To develop more cost-effective treatment technologies for use in the CTMP and bleached kraft pulp industries.

RELEVANCE:

There are currently three non-integrated CTMP mills operating in Canada. Several additional CTMP mill projects are between the proposal and start-up stages. One of the existing CTMP mills utilizes anaerobic-plus-aerobic biological wastewater treatment. The other two CTMP mills have constructed aerobic biotreatment systems. At least two of the three mills have encountered continual difficulties in meeting the applicable effluent regulations on a consistent basis. Nonetheless, in the provinces of Alberta and Saskatchewan, it has been projected that even more stringent effluent controls will be needed to adequately protect the environment. Improvements in environmental protection technology are clearly required for CTMP applications.

Most Canadian kraft pulp mills utilize some combination of chlorine, chlorine dioxide and hypochlorite to bleach softwood and hardwood pulps. Among the undesirable by-products of the bleached kraft process are chlorinated organic compounds that are known to be mutagenic, toxic, or environmentally persistent. Changes can be made to the bleaching process used in many kraft mills to reduce the quantity of organochlorines discharged. However, as long as chlorine-based compounds are used for pulp bleaching, some chlorinated organic material will be produced. It is anticipated that federal and provincial pulp and paper effluent regulations will be revised to include controls on the discharge of chlorinated organic material from bleached chemical pulp mills. Conventional and innovative treatment technologies are under development for toxics control in bleached kraft mill effluents.

WORK PLAN:

<u>CTMP Wastewater Treatment</u>

1) Provide technical assistance in the completion of an on-site pilot study on aerobic biotreatment of bleached CTMP (BCTMP) wastewater.

2) Provide technical assistance to Industry/Government program on development of chemical recovery systems and treatment technologies for BCTMP mills.

3) Complete assessment of ultrafiltration membrane characteristics and performance on selected CTMP wastewaters (with Physical/Chemical Processes Division).

4) Prepare final report on fate of resin acids in batch anaerobic and aerobic biotreatment systems.

Bleached Kraft Mill Effluents

1) Complete lab scale assessment of organochlorine removal in conventional biotreatment processes.

2) Initiate co-operative program with NWRI on environmental effects of biotreated bleached kraft mill (BKM) wastewaters.

3) Complete lab scale anaerobic treatment feasibility study on segregated bleachery effluents.

4) Complete assessment of ultrafiltration membrane characteristics and performance on bleach plant wastewaters (with Physical/Chemical Processes Division).

5) Initiate biological post-treatment studies for effluents from ultrafiltration or anaerobic pre-treatment systems.

6) Initiate experiments for feasibility study of membrane bioreactor for treatment of BKM wastewaters (with Zenon).

STATUS REPORT - JUNE 1990

Kraft Mill Bleach Plant Wastewaters

Several difficulties were encountered in the development of a system for controlling the laboratory activated sludge and ASB reactors at an operating temperature of 10°C. The installation of external cooling coils with circulating coolant allowed adequate temperature control to permit the start of experimental Run 4 at a temperature of 10°C and SRT of 15 days. Sampling for these conditions was completed on June 15 and the operating conditions were changed to 10°C and SRT of 5 days.

A series of experimental runs were completed to evaluate the performance of high rate anaerobic reactors treating segregated bleach plant wastewaters at HRTs between 6 and 48 hr. Preliminary data indicate that the mean observed AOX removal efficiency of 65% was relatively insensitive to HRT and to the presence or absence of a readily biodegradable organic co-substrate (methanol).

After the completion of the anaerobic experiments, one of the reactors was changed to an alternating anaerobic/aerobic operating mode. With intermittent aeration, excessive loss of the reactor biomass has been a problem. An external solids settler has been installed to permit the return of effluent suspended solids to the reactor.

Batch experiments are continuing to examine the efficacy of modified polyurethane foam carriers for anaerobic treatment of bleach plant wastewater. Similar techniques are also being used to assess AOX removal under facultative conditions with, and without co-substrate addition.

The assembly of a small-scale anaerobic membrane bioreactor for the treatment of segregated kraft mill bleach plant wastewaters was substantially completed and preliminary equipment testing has
been initiated. Two membrane modules were delivered by Zenon for inclusion in the pilot plant.

A preliminary design for laboratory scale oxic fluidized bed reactors was prepared, and the required equipment has been ordered. This equipment will be used to assess the efficacy of ultra-high rate aerobic treatment for toxicity and AOX removal from bleached kraft combined mill effluents.

Chemi-thermomechanical Pulping Wastewaters

The final report on the fate of resin acids in anaerobic and aerobic batch studies was completed and submitted to the WTC and McMaster University. No further work on CTMP effluents is being contemplated, pending the outcome of the closed-mill concept that is presently under construction at the new BCTMP mill in Meadow Lake, Saskatchewan.

MacMillan Bloedel, Sturgeon Falls, Ont.

The full scale UASB anaerobic treatment facility was put into start-up operation in June. No performance data are available at this time.

Quesnel River Pulp, Quesnel, B.C.

QRP has requested the use of the Biological Processes Division pilot plant trailer for an on-site pilot study on the post-treatment of anaerobic effluent at a BCTMP mill. The trailer is currently located in Whitecourt, Alberta where a 100% aerobic treatment approach is being examined for aspen BCTMP wastewater.

STATUS REPORT - September 1990

Kraft Mill Bleach Plant Wastewaters

The laboratory scale activated sludge and ASB reactors were operated under pseudo-steady state conditions in Run 5 at a temperature of 10°C and SRTs of 5 days. Sampling for these conditions was completed on July 27 and the operating conditions were changed to 10°C and SRTs of 10 days. The completion of Run 5 marks the end of the preliminary experimental program. The results of this program are currently under review for a presentation at the joint Bioqual/Biofor meeting in Fredericton on October 31.

During the compilation and analysis of the preliminary experimental data, the laboratory scale treatability units were maintained in operation in Run 6 at a temperature of 10°C and SRTs of 10 days. Sampling for these conditions was completed on August 30 and the operating conditions were changed to 25°C and SRTs of 5 days.

Laboratory scale studies were continued to elucidate the mechanisms of removal of chlorinated organic compounds during anaerobic treatment of segregated bleached kraft mill effluents. Results from these studies are not yet available.

One laboratory scale oxic fluidized bed reactor has been constructed and subjected to hydraulic testing. In September, the reactor was seeded with activated sludge and the treatment of a partially-simulated bleached kraft whole mill effluent was started at an HRT of approximately 4.5 hours. No performance data are available at this time.

Operation of the laboratory scale anaerobic membrane bioreactor was also initiated in September. The unit was seeded with acclimated anaerobic sludge and bleach plant effluent treatment was started at a 2 day HRT. The bleach plant effluent COD is currently being supplemented with a methanol co-substrate. A number of equipment failures caused several temporary disruptions of the start-up program. However, by the end of September, these problems had been satisfactorily resolved and the reactor was operating continuously.

Treatment of Sulfite Mill Effluents

Preliminary discussions have been held with two pulp and paper companies to explore research needs for wastewater treatment in the sulfite pulping sector. A sample of red liquor from one mill was received at the WTC for characterization and basic treatability assessment under aerobic and anaerobic conditions. No decisions on a WTC program in this area have been made at this time.

Quesnel River Pulp, Quesnel, B.C.

Agreement was reached with QRP to relocate the Biological Processes Division pilot plant trailer from Whitecourt, Alberta to Quesnel, B.C. The trailer will be used for an on-site pilot study on the post-treatment of anaerobic effluent at a bleached CTMP mill. The program, to be funded by QRP and the B.C. government, is expected to require 12 to 15 months for completion. The trailer was moved from Whitecourt to Quesnel, B.C. on September 4.

MacMillan Bloedel, Sturgeon Falls, Ont.

E. Hall visited the full scale anaerobic treatment plant at Sturgeon Falls on August 8. The Biothane system has been operating for approximately 2 months and is still in the early start-up phase.

Western Pulp Partners, Port Alice, B.C.

The pilot scale anaerobic plant has continued to operate poorly on a 7:1 mixture of caustic extract and acid condensate from the dissolving sulfite mill at Port Alice. Arrangements were made for the shipment of samples of the pilot plant influent and effluent to the WTC for serum bottle toxicity screening and treatability testing. A pilot scale activated sludge system was also installed at the mill. Initial results indicate satisfactory BOD and toxicity removal under aerobic treatment conditions.

PROGRAM AREA: COMPLIANCE MONITORING METHODOLOGY

PROJECT 68105: PLANT PERFORMANCE MONITORING

PROJECT MGR: D.T. Chapman **TEL:** (416)336-4621

OBJECTIVE:

To develop and analyze computer databases containing MISA data for Ontario petroleum refineries and Ontario pulp and paper mills.

RELEVANCE:

Currently, under the province of Ontario's Municipal-Industrial Strategy for Abatement (MISA) program, nine industrial sectors and municipal treatment plants are required to monitor discharge streams for a 12-month period and report fish and daphnia toxicity values and conventional and trace contaminant concentrations for more than 100 compounds. The databases generated by the MISA monitoring program are large, complex, and provide a valuable resource for assessing the performance of existing treatment technology. A joint program with the Ontario Petroleum Association (OPA) is underway to develop, manage, and analyze a MISA database for the 7 petroleum refineries in the province of Ontario. A similar program with the Ontario Forest Industries Association (OFIA) is being planned for the MISA data generated by the 27 Ontario pulp and paper mills. The results and methodology developed during the two programs will be valuable during effluent regulations development under the Canadian Environmental Protection Act (CEPA). The results from the pulp and paper mills directly support WTC programs to develop and evaluate treatment options for this key industry.

WORK PLAN:

1) Tabular reports for the entire 12 months of monitoring for the Ontario petroleum refineries will be generated, distributed, and reviewed.

2) A computer database will be developed for the MISA data from Ontario pulp and paper mills.

3) Tabular summaries of the MISA pulp and paper data will be designed. The summaries will be generated and distributed to each of the mills and the OFIA.

4) The petroleum refinery and pulp and paper databases will be analyzed to determine the effect of assumptions about "ND" values on estimates of mean concentrations and loads; summarize and evaluate field QC data (blanks, spikes, and duplicates); calculate contaminant loadings per unit of net production; and establish data handling procedures for data flagged by MIDES comment codes.

STATUS REPORT - June 1990

1.) Petroleum Refinery Database:- Laboratory method detection limits (LMDLs) were received from the contract labs which analyze for trace compounds monitored on a quarterly basis. Esso (Sarnia) filed a resubmission indicating that toluene values previously submitted were in fact methyl isobutyl ketone (MIBK).

Additional database management and analysis activities were as follows:

a.) Field QC Data:- A brief technical note was prepared concerning anomalies detected at the Petrosar and Shell refineries. A report was finalized and distributed on June 26.

b.) Summary Data Tables:- Revised 12-month data tables were generated to aid in the preparation of the final project report.

c.) Interim Project Report:- Results from the QC report were incorporated into the project report. Data plots were reviewed and relevant comments added to the report. Total loadings were summarized. Copies of the draft final report were distributed to the OPA for review on June 26.

d.) Graphical Displays: "3-in-1" plots consisting of a time-series plot, a box plot and a probability plot on a single page were generated for the 17 frequently monitored parameters for the 7 refineries.

e.) Other:

- A table was generated expressing TSS loads per unit of production based on reference crude rates.

- WTC staff met several times during the quarter with the OPA's MISA Technical Committee to review the status of the project.

- WTC and OPA staff met with MOE personnel in Toronto on May 22 to discuss MOE's proposed protocol for calculating Performance Limits. An approach was developed and documented for calculating Performance Limits for Ontario petroleum refineries.

- A proposal ("Evaluation of Petroleum Refinery Discharges During the MISA Monitoring Program") and a Memorandum of Understanding (MOU) were prepared and forwarded to the OPA to cover a number of follow-up items arising from the database analysis.

2.) Pulp and Paper Database:- The Memorandum of Understanding (MOU) with the Ontario Forest Industries Association (OFIA) was finalized. The MOU supports the development of a database of flow, toxicity, and chemical concentration values collected under the MISA monitoring program for the 27 Ontario pulp and paper mills.

Questionnaires completed by the mills were received and the results entered into a Lotus spreadsheet. The questionnaires summarize the number and type of effluents to be monitored during the MISA program as well as the names, addresses, and phone numbers of contacts at the mills. As of June 30, 19 of the 27 mills submitted some or all of the data for the quarterly period, Jan.-Mar., 1990.

A preliminary set of templates was generated to specify the formats for the tabular summaries for the quarterly reports. Following discussions with OFIA's consultant, the templates were revised.

3.) Other:- WTC staff met with representatives from the Lambton Industrial Society (LIS) to review a project outline to enhance the existing LIS information system. Based on these discussions a draft project proposal was prepared. Discussions were also held with members of the organic chemical sectors to explore options for handling the MISA monitoring data for plants in the Sarnia area. A task outline was prepared for the development of a PC-based package which enable plants to evaluate their own MIDES data.

STATUS REPORT - September 1990

1.) Petroleum Refinery Database:

a.) Summary Data Tables:- FOD tables were generated using regulation method detection limits (RMDLs) as the censoring level instead of laboratory method detection limits (LMDLs). The total number of compounds detected across the petroleum refinery sector decreased from 78 to 62. The number of compounds which were detected at two or more refineries decreased from 42 to 29. A report summarizing the results was prepared and reviewed.

b.) Project Report:- Based on comments from refinery staff, revisions were made to the final draft of the report and the report was submitted to the Canadian Petroleum Producers Institute.

c.) Municipal/Refinery Sectors Comparison:- MISA monitoring results from Ontario petroleum refineries were compared to those for the municipal sector as reported in "Thirty Seven Municipal Water Pollution Control Plants", MOE, Dec. 1988. Excluding physical parameters, there were 99 compounds common to both programs. Petroleum refineries detected 37 compounds as compared to 54 compounds for secondary treatment plants reported in the 37-Plant Study. Additional comparisons were made on the basis of sector mean and maximum concentrations. A report summarizing the results was prepared.

d.) Performance Factor Calculations:- A review was conducted of the sample Performance Factor calculation provided by MOE. A meeting was held with MOE's statistician to resolve issues related to calculation methodology.

e.) Other:

- WTC staff met several times during the quarter with OPA's MISA Technical Committee to review project status and results.

2.) Pulp and Paper Database:

a.) Database Development:- MIDES ETF and TOXDATA diskettes were received from the mills and the data uploaded to the hard disk on WTC's HP-1000 minicomputer.

b.) Quarterly Tabular Summaries:- The quarterly report templates were reviewed and revised. Introductory notes for the quarterly reports were prepared. The notes document calculation procedures and provide the reader with guidelines for interpreting results. Copies of the quarterly report for the monitoring period, Jan. to Mar., 1990, were prepared and distributed to the mills.

c.) Other:

- A summary was prepared of the type and extent of production data forwarded by the mills.

- A set of tables was prepared listing individual lab method detection limits (LMDLs) and regulation method detection limits (RMDLs) for the mills.

- D. Chapman met with the Ontario Forest Industry Association's MISA Technical Committee to review the project status and results.

PROGRAM AREA: DEVELOPMENT OF ADVANCED BIOTREATMENT TECHNOLOGIES

PROJECT 68108: AUTOTHERMAL AEROBIC SLUDGE DIGESTION TECHNOLOGY DEVELOPMENT

PROJECT MGR: H. Melcer TEL: (416)336-4546

OBJECTIVE:

1) To evaluate the technical and economic feasibility of modifying existing aerobic sludge digesters to incorporate autothermal aerobic digestion (ATAD) technology.

2) To investigate the development and application of this technology as a technical and economical sludge handling alternative.

RELEVANCE:

In small communities of less than 10,000 persons, municipal wastewater treatment plant sludges are normally digested aerobically in preference to anaerobic digestion. This is becoming an increasingly expensive method of stabilizing sludges in view of escalating energy costs. More importantly, the digestion process has to occur over a 20 to 60 day period to meet jurisdictional requirements for pasteurization. The ATAD technology can achieve a similar product in a 4 to 6 day period. Such a modification offers considerable economic savings. This work addresses the needs of federal facilities and also those small municipalities that practice aerobic sludge digestion of which there are a large number in British Columbia.

WORK PLAN:

1) The performance of existing ATAD systems at the Salmon Arms, Gibsons Landing and Ladysmith, British Columbia were monitored during 1989. A performance assessment was conducted to demonstrate the relative success of retrofitting existing digesters (at nominal cost) with the more expensive alternate of installing new ATAD digesters as per German specifications. A report will be published by June 1990.

2) A follow-up evaluation of the application, economics, operational requirements and performance of the ATAD technology will be initiated. A research program will be developed and experimental work will be initiated at the Banff, Alberta STP.

STATUS REPORT - June 1990

1) A draft report on the work completed at the three ATAD sites in British Columbia was received from the contractor.

2) A meeting was held on May 15 with Mr. K. Deeny, contractor to the U.S. EPA in the application of ATAD technology, to review and discuss the activities in this area by EPA and WTC to date. Preliminary discussions were also held on the potential research activities associated with optimizing the process at the Banff STP. It was agreed to provide the results from the Dayton and Knight work in B.C. as soon as available for possible inclusion in a comprehensive EPA manual currently being prepared.

A draft copy of the ATAD Design Manual prepared by the EPA was forwarded to the WTC and reviewed by Biological Processes staff. Meetings to discuss further collaboration are planned for the next quarter.

STATUS REPORT - September 1990

1) A final report on the evaluation of the ATAD technology at three sites in British Columbia was accepted from the contractor. Data from one of the test sites was used as a case history for the USEPA ATAD design manual which is to be published at the 1990 Annual WPCF Conference in October. The project concludes several years of investigation and one year of plant evaluations at Ladysmith, Salmon Arms and the Town of Gibson.

   The three facilities provided a comparison of the industry standard in Ladysmith (a two tank facility developed by Fuchs Gas & Wassertechnik GmbH) and marketed as Aerobic Thermophilic Stabilization (ATS), a retrofit design in Salmon Arms (two cells in an existing rectangular concrete structure) and a special case design in Gibsons where a two tank aerobic thermophilic digestion system was operated in conjunction with an aerobic mesophilic digester (dual digestion). All three systems met the objectives of sludge stabilization and pasteurization as well as minimal odour production. Sludge dewaterability appeared to be site specific. Oxidation-reduction potential (ORP) and temperature were identified as valuable parameters for assessing biomass integrity. Control of sludge feed rate was identified as the most important variable affecting reactor performance.

2) Mr. K. Deeny of Junkins-Deeny Engineering, contractor to the U.S. EPA in the application of ATAD technology, met with WTC and Aquatrol Technologies personnel in Banff to review the ATAD process operation. Appropriate areas of investigation for process optimization, research and development were also identified and discussed. Followup meetings between Mr. Deeny, U.S. EPA and WTC are scheduled to be held in the next quarter to define a cooperative investigation in ATAD technology development.

PROGRAM AREA: **DEVELOPMENT OF ADVANCED BIOTREATMENT TECHNOLOGIES**

PROJECT 88119: **SECONDARY CLARIFIER RESEARCH**

PROJECT MGR: **D.T. Chapman** **TEL: (416)336-4621**

OBJECTIVE:

To plan, coordinate, and monitor international research activities relating to the design and operation of secondary clarifiers.

RELEVANCE:

Secondary clarifiers perform the dual function of removing suspended solids from the overflow to produce a clear effluent, and concentrating solids in the underflow so that an active biomass is maintained in the aeration basin. Inadequate knowledge concerning the fundamentals of clarifier design and operation is a major cause of inconsistent and unacceptable effluent from the activated sludge process.

An interagency agreement between Environment Canada and the U.S. Environmental Protection Agency is in place to support the activities of a group of experts, the Clarifier Research Technical Committee, to develop programs to address high priority research needs in the area of secondary clarification. The Committee is standardizing definitions pertaining to secondary clarifiers, establishing protocols for conducting clarifier research, promoting the use of statistical procedures for designing experiments and building models, establishing peer review procedures, and ensuring that research results are incorporated by consultants into new designs.

WORK PLAN:

1) The five-member steering committee will meet to review committee adminstration and activities.

2) The fifteen-member technical committee will meet in Washington D.C. in October to review and discuss innovative techniques for designing, operating, or evaluating secondary clarifiers.

STATUS REPORT - June 1990

Members of the Clarifier Research Technical Committee contacted a number of state and city agencies to obtain financial support for the field test program.

A Steering Committee meeting was scheduled for Los Angeles for July 21 to work out details of the field test program.

A project status report was prepared and submitted to the U.S. Environmental Protection Agency.

STATUS REPORT - September 1990

The Steering Committee met in Los Angeles, July 21 and 22, to review the status of CRTC activities and to work through a number of administrative and organizational issues relating to the field test program. The Committee will prepare a research proposal for the field program. L.A. County Sanitation District has agreed to provide a Principal Investigator who will supervise the field test engineer. The existing CRTC Steering Committee will provide overall program direction.

The first phase of the two-year field test program will be carried out at the San Jose STP, owned by L.A. County Sanitation District. During the second phase, data will be collected from a number of different sites. Sites under active consideration include Denver, New York City, Madison (Wisconsin) and Gresham (Oregon). Additional work is ongoing to identify a schedule for the field test program.

A CRTC technical and business meeting was scheduled for Washington, D.C., Oct. 11 and 12, following the annual meeting of the Water Pollution Control Federation.

PROGRAM AREA: DEVELOPMENT OF ADVANCED BIOTREATMENT TECHNOLOGIES

PROJECT 68121: ANAEROBIC PROCESSES DEVELOPMENT

PROJECT MGR: R.M. Jones **TEL: (416)336-4686**

OBJECTIVE:

To develop and demonstrate novel anaerobic processes and operating strategies for the treatment of concentrated organic wastewaters.

RELEVANCE:

Many industries which produce toxic and inhibitory wastewaters containing high concentrations of BOD are being faced with new, more stringent effluent regulations. In a number of cases, anaerobic processes have been demonstrated as a cost effective technology for treatment of these wastewaters. However, in some applications, process reliability must be improved and high operating costs caused by large alkalinity requirements must be reduced. The WTC has been investigating operation and control strategies to improve reliability and reduce alkalinity consumption in anaerobic treatment processes. A multicompartment reactor configuration recently developed by SNC Research Corporation may provide the operational flexibility required to implement these strategies.

WORK PLAN:

This project will initially consist of two separate streams of activity. The following list summarizes the tasks which will be completed in FY 90/91.

1) Development of Monitoring and Control Strategies for Anaerobic Treatment Processes

   i) Mechanistic dynamic models of high rate anaerobic treatment processes will be developed and calibrated using a dynamic data base generated on WTC pilot plants.

   ii) The models will be used to simulate possible monitoring and control strategies for anaerobic treatment processes.

   iii) Final reports will be generated on model development, calibration and utilization.

   iv) Experiments will be conducted to confirm pH control strategies which will minimize alkalinity consumption.

2) Multicompartment Anaerobic Reactor Investigation

   i) An agreement to undertake a cooperative process development program will be negotiated between the WTC and SNC, and an industrial partner to supply wastewater will be located.

   ii) A pilot plant will be constructed using a reactor supplied by SNC.

   iii) Steady state experimentation will generate baseline performance data.

STATUS REPORT - June 1990

An analysis of the existing supply of distillery wastewater revealed that little biodegradable substrate is now remaining in the wastewater after a long period of storage at the WTC. Because this wastewater is no longer available from Reider Distillery, and because there are no immediate plans for further dynamic experiments, the pilot plant was shut down. The shut down will allow cleaning and maintenance of pilot plant piping and instrumentation. If any further experiments are planned, an alternate wastewater source will need to be located.

Analysis of dynamic data from the fluidized bed acetic acid, propionic acid, butyric acid and glucose runs continued. A mechanistic model structure has been selected which has improved the performance of the model over those previously tested while reducing the number of kinetic parameters requiring experimental determination. An extended Kalman filter formulation of the model has been completed and simulation runs were conducted through the quarter to determine time-varying, stochastic terms in the model. Also, sensitivity analysis equations have been built into the package. A sensitivity analysis will determine the effects on model predictions of changes in stochastic and constant parameters. This will provide a basis on which to select a subset of the parameters for estimation and model fitting. Initial sensitivity analysis results have shown a number of complex interactions and indicated a wide variation in parameter sensitivity depending on the region of operation. The analysis will be completed by calculating parameter sensitivities for a number of representative operating regions.

Meetings and discussions were held between WTC staff and B. Safi of SNC Research to arrange a joint WTC/SNC demonstration program for the SNC Multiplate reactor. Discussions were initiated on the content of the program and an agreement in principle was made on a cost sharing arrangement. A pre-proposal for the program was written and submitted to SNC. However, a final arrangement which would be sufficiently beneficial to both parties could not be reached and discussions on the project were abandoned.

Metro Authority of Halifax-Dartmouth, NS.
Additional data has been requested from the Metro Authority to permit the completion of the final DRECT project report.

STATUS REPORT - September 1990

Analysis of dynamic data from the fluidized bed acetic acid, propionic acid, butyric acid and glucose runs continued. Sensitivity analysis equations were built into the mechanistic modelling package. A sensitivity analysis was conducted to determine the effects on model predictions of changes in stochastic and constant parameters. This will provide a basis on which to select a subset of the parameters for estimation and model fitting. Initial sensitivity analysis results showed a number of complex interactions and indicated a wide variation in parameter sensitivity depending on the region of operation. The analysis was completed by calculating parameter sensitivities for a number of representative operating regions. Parameter estimation runs are being conducted using simulated data sets to assess parameter identifiability and to tune the estimation algorithm. Final parameter estimation runs will be completed for the experimental data sets.

Scoping has begun for investigations of the potential application of anaerobic processes to the treatment of wastewaters from the organic chemicals sector. A specific anaerobic process modification has been identified for possible initial investigations. Initial discussions have been held with NOVA Petrochemicals Inc. in Sarnia regarding potential supply of wastewater samples. As a result of these discussions, a proposal on this process development project will be written and submitted to NOVA.

Metro Authority of Halifax-Dartmouth, NS.

Additional data has been requested from the Metro Authority to permit the completion of the final DRECT project report.

6th International Symposium on Anaerobic Digestion

A total of 204 abstracts were received for consideration for presentation at AD-VI in São Paulo, Brazil. Abtracts were forwarded to other members of the Program Committee for review.

PROGRAM AREA: **OTHER PROGRAM AREAS**

PROJECT 68101: **DEPARTMENTAL TECHNOLOGY SUPPORT**

PROJECT MGR: **H. Melcer** **TEL: (416)336-4546**

OBJECTIVE:

To provide technical support to C&P regional offices and Federal facilities with respect to biological technology for the treatment of municipal and industrial wastewaters.

RELEVANCE:

Supports all departmental priorities.

WORK PLAN:

To provide, as requested, technical advice and program review to government personnel.

1) Most regions have requested technical support in developing technology and process information to reduce the toxicity of pulp and paper sector wastewaters. These concerns are being addressed in project 29.

2) The Ontario regional office requires continuing support in the Ontario MISA program and in meeting the federal government's Great Lakes obligations. This issue is being addressed in projects 03 and 04 (municipal sector), 05 (petroleum refinery and pulp and paper sectors), and 29 (pulp and paper sector).

3) It is anticipated that the Centre St. Laurent will require some technical support.

4) Support to regional offices will continue with respect to sewage treatment plant design and operation.

STATUS REPORT - June 1990

H. Melcer attended a program review meeting with staff of the Atlantic Region in Dartmouth, N.S. on June 7. The abandoned coke plant site in Sydney, N.S. was visited on June 8 to discuss potential research regarding the remediation of this site.

Western and Northern Region

E. Hall attended a meeting on May 1 at the offices of Alberta Environment in Edmonton to review the revised Athabasca pulp mill proposal as presented by representatives of Alberta-Pacific Forest Industries Inc. On May 10, discussions were also held with M. Holloran of Beak Consultants to obtain an update on recent results from laboratory scale pulping and bleaching trials being carried out under contract to AlPac. E. Hall also attended a second meeting with Alberta Environment in Montréal on June 13 to evaluate Paprican's assessment of the new manufacturing technologies proposed by AlPac.

Pacific and Yukon Region

At the request of L. Adamache, E. Hall visited the Western Pulp Partners sulphite mill at Port Alice B.C. on June 19 and 20 to review progress to date in a pilot scale anaerobic treatment program. A number of operational difficulties have been encountered since the pilot plant feed

make-up was altered to include alkaline bleach plant effluents. A meeting was also held with B.C. MOE and McMillan Bloedel Ltd. technical staff at the Alpulp mill in Port Alberni B.C. to review results from the WTC pulp and paper programs and anticipated forms of the new federal and provincial pulp and paper effluent regulations. McMillan Bloedel staff also presented updates on the status of the pollution control programs for the three coastal pulp mills operated by the company. On June 21, E. Hall visited the Harmac mill in Nanaimo with C&P P&YR staff to review the results of the pilot scale activated sludge process design and treatability study that is currently under way.

Industrial Programs Branch
At the request of RREP Division of IPB, E. Hall attended at meeting in Hull on May 28, with representatives of several Canadian CTMP mills. The CTMP industry presented several concerns regarding the proposed federal pulp and paper effluent regulations, and suggested a number of revisions that would make the proposed regulations more appropriate for the CTMP sector.

Status Report - September1990

Headquarters: Alberta-Pacific Scientific Review Panel
E. Hall attended meetings of the Panel in Edmonton on July 23rd and between August 21 and August 27th. On September 5, the Panel visited the Skookumchuk, B.C. bleached kraft pulp mill operated by Crestbrook Forest Industries. The Crestbrook mill incorporates a peroxide- and oxygen-reinforced alkaline extraction stage that is similar to that proposed for the Athabasca mill. The Crestbrook mill also utilizes a rapid infiltration system for ultimate disposal of effluent from the ASB secondary treatment plant. The public review sessions required under Ministerial Order 9/90, were held in a workshop setting in Athabasca, Alberta from September 12 to 14, 1990. The Panel's report was then prepared and printed over the subsequent sixteen days and was presented to the Alberta Minister of the Environment, in Edmonton, on October 1, 1990.

Industrial Programs Branch
Work was initiated on a summary report of data from the CPPA National Dioxin Sampling program. In early 1989, effluent samples were collected from all bleached pulp mills in Canada for analysis of dioxins and furans. The data from the British Columbia mills was analyzed earlier by WTC staff at the request of IPB. A similar analysis will be completed for the entire Canadian database.

Ontario Region
Reports on the Northern Wood Preservers plant performance at Thunder Bay were reviewed for the Ontario Region (Toronto) office.

Pacific and Yukon Region
A consultant's report on sewage treatment and disposal options for the City of Whitehorse was reviewed for the Whitehorse office.

PROGRAM AREA: OTHER PROGRAM AREAS

PROJECT 68102: GREAT LAKES REMEDIAL ACTION PLAN TECHNOLOGY SUPPORT

PROJECT MGR: H. Melcer **TEL:** (416)336-4546

OBJECTIVE:

To provide technical support to the Great Lakes Remedial Action Plan with respect to biological technology for the treatment of municipal and industrial wastewaters.

RELEVANCE:

Supports the Great Lakes issue.

WORK PLAN:

To provide technical advice and program review on an as required basis.

STATUS REPORT - June 1990

No activity to report.

STATUS REPORT - September 1990

Following approval, specific projects have been initiated to address Great Lakes RAP issues and are described in detail in projects 04, 05, 10, 16 and 29.

PROGRAM AREA: OTHER PROGRAM AREAS

PROJECT 88109: BIOLOGICAL TREATMENT OF CONTAMINATED GROUNDWATERS AND SOILS

PROJECT MGR: H. Meiwes TEL.: [redacted]

OBJECTIVE:

1) To become cognisant of the state of the art and current research activities regarding biological treatment of contaminated groundwaters.

2) To develop a program that investigates the application of biological processes to contaminated groundwaters.

RELEVANCE:

It has been demonstrated that instances of contaminated groundwater exist in Canada. Programs have been initiated to examine the effectiveness of physical-chemical unit operations in the remediation of contaminated groundwaters. Extensive work is being pursued in the U.S.A. on in situ and above ground biological treatment of contaminated groundwaters. It is appropriate that biological treatment be evaluated as an alternative treatment option.

WORK PLAN:

1) To review pertinent literature and meet with appropriate researchers to establish the status and degree of success achieved with in situ and above ground biological treatment systems.

2) To develop a program of investigations for FY 1990/91.

STATUS REPORT - June 1990

An EPA-sponsored workshop held in Oklahoma City on contaminated groundwater and soil remediation was attended. The workshop is held annually in April by invitation and serves as a forum for all EPA contractors to report on the status of their programs.

A workshop on remediation of wood preservation plant sites sponsored by Mississippi State University on June 5-6 was attended.

The abandoned coke plant site at Sydney, N.S. was visited on June 8 to discuss its potential for serving as a site to develop remediation measures specific to coal gasification sites.

STATUS REPORT - September 1990

A survey of coal tar contaminated sites that have been remediated is on-going as is a literature review of lab- and pilot-scale studies of the biodegradation of PAHs in soil.

The oil tar-contaminated Ultramar site in Port Stanley was visited. Full-scale bioremediation using landfarming and microbial augmentation (P. putida) began in mid-August. At the time of the visit, results of the clean-up were not available. The pilot study report indicated an 86% decrease in total PAHs over 31 days but the mechanism by which this occurred could not be definitively attributed to biodegradation.

The AWMA Annual General Meeting on the Decommissioning of Sites and Facilities was attended. Remediation Technologies Inc. indicated that it has an on-going laboratory research program to study the feasibility of using biological treatment to remediate soils containing residues from MGP sites. The results of these studies should prove useful in the assessment of the feasibility of bioremediating sites contaminated with coal tar.

PROGRAM AREA: **OTHER PROGRAM AREAS**

PROJECT 68110: **STEP FEED TECHNOLOGY DEMONSTRATION**

PROJECT MGR: D.T. Chapman TEL: (416)336-4021

OBJECTIVE:

Demonstrate the effectiveness of step feed control to reduce effluent and bypass discharges during storm events at a full-scale wastewater treatment plant.

RELEVANCE:

For many activated sludge plants, the step feed control strategy offers the potential for reducing the concentration of suspended solids discharges resulting from storm flows. During step feeding, an operator adds influent at one or more points along the length of the aeration basin, decreasing the solids loading to the final settler. A pilot scale study at the Wastewater Technology Centre documented that step feed operation was effective for preventing the washout of solids at flowrates shown to cause washout without step feed. Despite its effectiveness, step feed operation has not found wide-spread utilization at municipal treatment plants in Canada. A project is underway to demonstrate step feed control during storm flows at a full-scale municipal treatment plant. Plant performance with and without step feed is to be demonstrated. The demonstration will also provide operator training in step feed operation.

WORK PLAN:

1) Demonstrate the effectiveness of step feed control during storm flow periods at the Dundas WWTP. The reduction in pollutant loading to the receiving water due to step feed operation will be quantified.

2) Formulate step feed control strategies for use at the Dundas and Wentworth Ave WWTPs.

3) Provide training for plant operators in the use of step feed control by providing a training package and conducting seminars in conjunction with the demonstration project.

STATUS REPORT - June 1990

1.) Equipment Installation & Maintenance:- All on-line instrumentation was installed at the Dundas STP and interfaced to the data logger. Automatic samplers were installed. The instrumentation and data management system were tested. The grit chamber bypass was blocked and a weir was installed in the Plant A (the plant with step feed capabilities).

2.) Experimental Plan:- The experimental plan was prepared and approved by the Project Liaison Committee.

3.) Data Collection:

a.) Base-line data:- On- and off-line data were collected under normal operating conditions during the quarter and the data reviewed.

b.) Experimental data collection:- Plant A was operated in the step feed mode with the entire flow diverted to Plant A. The level of performance was comparable to Plant B (operated normally, without step feed). The performance of Plant A was monitored under storm flow conditions. The results indicated that the step feed plant could handle the high flows with minimal degradation in effluent quality.

Flows were diverted to Plant A during normal operation to establish the rates which caused washout in the final settlers.

4.) Other:-

A Project Liaison Committee meeting was held on June 15 to review the status of the project to date. The Committee recommended that the work at Dundas be completed and planning initiated for Phase 2 of the project at the Woodward Ave. plant. The consultant met with Woodward Ave plant staff to determine instrumentation for Phase 2. A list of instrumentation requirements and a revised cost estimated were prepared.

STATUS REPORT - September 1990

1.) Phase 1 (Dundas):

Collection of base-line data was completed. Some instrumentation was removed in preparation for Phase 2. Experimental data were reviewed.

Arrangements were made for a seminar on the use of step feed operation to mitigate the impact of storm flows on STP performance. The seminar was held at the Canada Centre for Inland Waters on Sep. 11. Approximately 80 people attended. Participants also visited the Dundas STP.

2.) Phase 2 (Woodward Ave.):

Work was initiated at the Woodward Ave STP in preparation for installation on-line sensors and monitoring equipment.

PROGRAM AREA: **OTHER PROGRAM AREAS**

PROJECT 68115: **TECHNOLOGY TRANSFER**

PROJECT MGR: **H. MELCER** **TEL: (416)336-4546**

OBJECTIVE:

To transfer technology investigated and developed by the biological processes division.

RELEVANCE:

The biological processes group has extensive experience in process design, control, and investigation of activated sludge systems, fixed film systems, and anaerobic systems through current and previous in-house research programs. The transfer of this knowledge base is important in providing technical support of all departmental priority issues.

WORK PLAN:

1) To provide biological process technology assistance and support, on an as requested basis.

2) The continued participation of WTC staff in the ongoing WTC/Swedish VAV technical exchange program.

STATUS REPORT - June 1990

G. Speirs and B. Jank made presentations on various aspects of flow monitoring in wastewater treatment as part of the ITA-sponsored Flow Measurement Workshop held in Philadelphia April 3-4.

STATUS REPORT - September 1990

G.Speirs made presentations on various aspects of flow monitoring in wastewater treatment as part of the Water & Wastewater Instrumentation Testing Association (ITA)-sponsored Flow Measurement Workshop held in Chicago July 12, 13. Discussions on presenting this workshop at additional venues in 1991 have been initiated.

PROGRAM AREA: CONTAMINATED GROUNDWATER TREATMENT

PROJECT 68585: **GROUNDWATER TREATMENT DEMONSTRATION - UNIROYAL**

PROJECT MGR: **R. BOOTH** **TEL: (416) 336-4689**

OBJECTIVE:

1) To demonstrate technically feasible, cost effective technologies for the treatment of contaminated groundwater at an organic chemicals plant.
2) To provide technology transfer for the benefit of other sites in Canada.

RELEVANCE:

The remediation of contaminated sites is extremely expensive and requires the application of efficient, site specific yet cost effective technologies. Many current remedial technologies need to be critically assessed and new and innovative technologies must be developed and demonstrated to resolve these problems.

WORK PLAN:

1) Undertake the Scientific Authority duties for the contract including chairing technical and management committee meetings, ensuring work is carried out in accordance with the contract, etc.
2) Review contractor's reports and provide comment.
3) Provide technical advice on treatment technologies.
4) Provide technical and other support for the conduct of the treatability studies.
5) Prepare technical presentations on the work done for poster sessions, technical papers, newsletter articles, etc.
6) Work in cooperation with EETD in demonstrating phys/chem technologies.

STATUS REPORT - JUNE 1990

Work continues to be on hold due to Uniroyal's restriction on effluent discharge. Regular contact with Jeff Merriman is maintained.

A meeting was held with MOE to discuss the future of the project and options to complete the work. It was decided to terminate CH2M Hill's contract. The option of WTC completing the pilot work on site is under discussion.

STATUS REPORT - SEPTEMBER 1990

CH2M Hill is preparing the final project report. A draft version is scheduled for the end of October.

Discussions with Uniroyal and MOE regarding WTC completing the Phase 2 pilot work with the SBR and expanding the groundwater treatability study to other processes are on going.

PROGRAM AREA: CONTAMINATED GROUNDWATER TREATMENT

PROJECT 68586: **TREATMENT OF CONTAMINATED GROUNDWATER AND SOIL**

PROJECT MGR: **R. BOOTH** **TEL: (416) 336-4689**

OBJECTIVE:

1) To assess the existing treatment technologies and develop and demonstrate technically feasible, cost effective technologies for the treatment of contaminated groundwater and soil.
2) To provide technical support to C&P, other federal and provincial agencies, industry and other practitioners in resolving groundwater and soil contamination problems.

RELEVANCE:

Contaminated groundwater and soil through poor waste management practices, leaking storage tanks and ponds, spills, etc., is a high priority environmental problem. The remediation of contaminated sites is extremely expensive and requires the application of efficient, site specific yet cost effective technologies. Many current remedial technologies need to be critically assessed and new and innovative technologies must be developed and demonstrated to resolve these problems.

WORK PLAN:

1) Undertake iron and manganese pretreatment R&D utilizing aeration, chemical oxidation, sequestering and adsorption. Investigate the role of particle interaction and groundwater geochemistry.
2) Undertake iron and manganese pretreatment field study at the Gloucester Landfill Site.
3) Participate on the Gloucester Remediation Committee throughout FY 1990/91.
4) Develop and undertake remedial technology R&D at the Expo Site in B.C.
5) Undertake a DMNA adsorption and degradation study.
6) Participate in the development of a Waste Sites Monitoring Manual.
7) Participate in the development of the DESRT program.
9) Provide advice to industry, the Regions and other government departments.

STATUS REPORT - JUNE 1990

Assistance was provided to Battelle in organizing the In-Situ and On-Site Bioreclamation International Symposium of which Environment Canada is a co-sponsor. The symposium will be held March 19-21, 1991, in San Diego, California.

The organization of the biorestoration session of BIOQUAL'90 was completed. The conference will be held October 29 - November 2 in conjunction with BIOFOR in Fredericton, New Brunswick.

A proposal was prepared and discussed with BC MOE on remediation technology R,D&D at the Pacific Place Site in Vancouver. Information was provided to BC MOE for a brief presentation at the June 14th DESRT meeting in Montreal. During the development of the proposal, meetings were held with Eric Koglin, EPA Environmental Monitoring Systems Laboratory, to discuss real time monitoring systems and the potential for joint work at the Pacific Place Site. A meeting and follow-up discussions were also held with Drs. Kent Udell

and Nick Sitar of the University of California at Berkley, to discuss the potential for joint research on DNAPL treatment using steam injection.

The draft National Groundwater Strategy document was reviewed and comments sent to John Gilliland, IWD.

The work plan for the iron and manganese pretreatment program was prepared. A bench scale aeration column and filter have been fabricated and hydraulically tested. A system to minimize the oxidation of iron when collecting samples has been designed and is under fabrication.

The following conferences, symposia and workshops were attended:

EPA R. S. Kerr Laboratory Research Symposium in Oklahoma City, April 2 - 4.

Immiscible Fluids in the Subsurface Conference, April 18 -20, in Calgary.

NWWA Outdoor Action Conference on Aquifer Restoration, Groundwater Monitoring and Geophysical Methods, May 14-17, Las Vegas, Nevada.

EPA Hazardous Waste Symposium in Cincinnati, Ohio, April 2 - 4.

Contaminated Sites Remediation Program
Site Assessment and Ranking Workshop in Ottawa, April 23 & 24.

STATUS REPORT - SEPTEMBER 1990

General

Assistance continues to be provided to Battelle in organizing the In Situ and On-Site Bioreclamation International Symposium of which Environment Canada is a co-sponsor. The symposium will be held March 19 -21, 1991, in San Diego, California.

The second draft of the National Groundwater Strategy document was reviewed and comments sent to John Gilliland, IWD.

Marc Halevy attended the NWWA Groundwater Geochemistry Course on Sept 17-19 in Toronto.

Pacific Place, B.C.

The Pacific Place Site R,D&D proposal continues to be developed with B.C. Ministry of the Environment. Meetings were held with MOE and the Hazardous Waste Management Corporation in August and with MOE in September.

A revised proposal was prepared jointly by R. Booth and John Wiens for presentation to BC MOE and the DESRT Technical Committee.

Iron Pretreatment

A work plan was prepared, circulated for review and is currently being revised. The initial emphasis is on the oxidation of iron using fine bubble aeration coupled with direct filtration. Particle interaction and the synergistic removal of manganese will be studied.

J. Dart, MOE, and Prof. M.E. Weber, McGill University, have agreed to be advisors on the project. McGill students will participate in the program using Ville Mercier water as part of their course work from January to April '91.

Several sampling trips were made to wells in the Region of Waterloo. A cooperative arrangement with the Region is being developed for future WTC field work.

A sensitive colorimetric method was developed for manganese determination.

Development & Demonstration of Contaminated Sites Remediation Technology (DESRT)

R. Booth has participated extensively in the program. Proposals were reviewed and advice/comments provided to TDB. Presentations were made to the provinces on GASReP and projects of federal interest in a cross Canada tour. The Technical Committee meeting in Vancouver, on September 24, was attended and presentations were made.

Gloucester

At the request of Transport Canada, WTC and EETD agreed to undertake an assessment of air stripping and enhanced oxidation (UV, hydrogen peroxide, ozone and combinations) treatment of groundwater from the special waste plume. A work plan was developed and sent to EETD for comment. WTC provided on-site laboratory services for iron analysis, VOC and other organic analysis through Lab Services Division, a filtration unit to allow continuous operation and field technical support. The project, which was originally scheduled to be completed by September 28, is expected to be completed by mid-October.

PROGRAM AREA: CONTAMINATED GROUNDWATER TREATMENT

PROJECT 99987: **NATIONAL GROUNDWATER AND SOIL REMEDIATION PROGRAM (GASReP)**

PROJECT MGR: **R. BOOTH** **TEL: (416) 336-4689**

OBJECTIVE:

1) To conduct research, development and demonstration activities on technologies to resolve hydrocarbon contamination problems.
2) To produce state of the art reports on technology at the research, demonstration and commercial stages which also scope out research needs.
3) Undertake technology transfer to enhance remediation efforts in Canada and avoid duplication of R&D effort.
4) Expansion of GASReP to include chlorinated organic chemicals.

RELEVANCE:

One of the environmental problems caused during the extraction of conventional oil and gas resources, "heavy oils" by mining of the tar sands and in-situ production techniques, the production of "new" fuels and in the production of chlorinated organics is the contamination of groundwater and soil. This can occur at any point in the production stage, upgrading stage, distribution, and use of these products to produce other organically based products of value to society. The contamination of groundwater may occur as a result of improper waste management procedures, failures of equipment, spills during storage, handling and transportation, etc. As some 26% of the Canadian population relies on greundwater as a source of drinking water, contamination of the associated aquifer and recharge zones can have serious repercussions. Numerous cases of groundwater and soil contamination are on record.

GASReP is a cooperative effort by WTC, EMR, PACE, CPA, API, EPA, B.C., Alberta, Ontario, Quebec, P.E.I. and New Brunswick to address these problems. The program, initiated in 1988/89, identifies R,D&D needs, scopes out projects, sets priorities and undertakes R,D&D activities. Technology transfer is a key component.

WORK PLAN:

1) Organize and participate in groundwater and soil remediation technology transfer conferences/symposia for the Downstream (refining, storage, distribution) sector, for advanced oxidation processes, and for GASReP R,D&D initiatives.
2) Chair the Steering Committee, the Excavate & Treat and Soil Venting and Off-gas Technical Sub-committees.
3) Complete research scoping studies for in-situ bioremediation, excavate and treat, and in-situ volatilization remedial technologies to establish a knowledge baseline.
4) Undertake a research scoping study for pump and treat remedial technology.
5) Initiate development and field demonstrate cost effective off-gas treatment technologies.
6) Assist IPB in a project to assess technologies for the remediation of hydrocarbon contaminated groundwater at sour gas plants.
7) Undertake a site characterization and instrumentation study for future field demonstrations at a selected site.
8) Participate in a PACE workshop on soil remediation and in IPB land treatment seminar.
9) Conduct field trial of in-situ biological barriers.
10) Participate in EETD solvent extraction study.

11) Undertake a vendor technology study for treatment of contaminated soils, jointly with CPA and IPB.
12) Demonstrate pump and treat technologies at a sour gas plant.

STATUS REPORT - JUNE 1990

The PERD annual report and proposal for 1991/92 was prepared. A presentation on the program and the proposal was made to the PERD 4.8 Generic Environment Committee.

The second draft of the literature review and research scoping study for off-gas treatment was reviewed and the final draft incorporating comments is being prepared.

The program for the downstream petroleum industry conference to be held in Montreal, October 16 and 17, 1990 was finalized and involvement in the organizing committee continues.

Progress meetings held in Ottawa for the Excavate and Treat Literature Review and Research Scoping Study were attended.

Technical subcommittee meetings were held and progress reports made by the contractors on the various projects underway. All projects are delayed by several months. CPPI has been notified accordingly so that the contracts can be amended.

The AOP Symposium, held June 4 & 5 in Toronto, had 125 attendees and was highly successful. EPA has suggested holding a joint conference next year in the US.

Assistance was given to CPPI in organizing and running a workshop on hydrocarbon contaminated soil remediation. It was held in Winnipeg on May 6-9.

The Steering Committee met on May 2 at WTC to approve projects and discuss administrative aspects. A. Jolicoeur and G. Hill attended to discuss DESRT and potential GASReP involvement.

A presentation on GASReP was made at the June 14th meeting of the DESRT Technical Committee in Montreal. A suite of proposals was put forward for support.

A meeting was held with CPPI (formerly PACE) to discuss their on-going support of GASReP with Bob Squires leaving at the end of June.

STATUS REPORT - SEPTEMBER 1990

The final report on the literature review and research scoping study for off-gas treatment is being prepared and is scheduled for completion at the end of October.

Involvement in the final arrangements for the downstream petroleum industry conference to be held in Montreal, October 16 & 17, 1990 continued.

In-situ Bioremediation and Excavate & Treat Technical Subcommittee meetings were held in Charlottetown, PEI and progress reports made by the contractors on the various projects underway. All projects are delayed by several months.

Discussions were held with CAWPRC regarding a special edition of their journal based on peer reviewed papers from the AOP Symposium held June 4 & 5 in Toronto.

PROGRAM AREA: CONTAMINATED GROUNDWATER TREATMENT

PROJECT 6659: **TREATMENT OF GROUNDWATER AND OFF-GAS USING ADVANCED OXIDATION PROCESSES**

PROJECT MGR: **R. BOOTH** **TEL: (416) 336-4959**

OBJECTIVE:

1) To develop and demonstrate technologies for the treatment of organic chemicals in the off-gas from volatilization remedial technologies.
2) To provide technology transfer for the benefit of other sites in Canada.

RELEVANCE:

The remediation of contaminated sites is extremely expensive and requires the application of efficient, site specific yet cost-effective technologies. Many remedial technologies generate off-gases which contain organic compounds of concern which need to be treated. Current off-gas treatment technologies are few and extremely expensive. Though adsorption on GAC is the norm, in many places this is simply a transfer to a solid phase and subsequent treatment is required. Alternative technologies must be developed and demonstrated to resolve these problems.

WORK PLAN:

1) Develop and demonstrate at bench scale an enhanced photo-oxidation process to treat off-gas contaminated with simple aromatic hydrocarbons.
2) Extend the bench work to include chlorinated hydrocarbons.
3) Investigate the use of adsorbents such as peat and biobone for gas phase contaminants and the development of biomass on this media to degrade adsorbed contaminants.
4) DMNA photo oxidation study on Elmira groundwater.
5) Prepare reports on the above work with recommendations for future work leading, if appropriate, to field scale demonstration.

STATUS REPORT - JUNE 1990

A final report on the bench scale AOP treatability study on DMNA was prepared and sent to CH2M Hill.

A pilot scale treatability study using a low pressure UV system at well E9 in Elmira was completed. The results supported the bench scale findings. A draft report was prepared.

Two meetings were held with CH2M Hill and Lab Services to discuss the DMNA photolysis byproducts study. Lab Services prepared a brief progress report and sent it to CH2M Hill.

Discussion with Dr. Jack Rosenfeld of McMaster University, Dr. Bill Cairns of Trojan, and Dr. John Carey of NWRI to develop a proposal for the treatment of contaminated groundwater and associated gas streams has been on-going.

STATUS REPORT - SEPTEMBER 1990

The pilot scale treatability study report was submitted to CH2M Hill for comment.

A meeting was held in September with CH2M Hill and Lab Services to discuss the DMSA photolysis byproducts study and the pilot study. WTC is still awaiting CH2M Hill's written comments on the byproducts study before finalizing the report.

PROGRAM AREA: CONTAMINATED GROUNDWATER TREATMENT

PROJECT #6880: VILLE MERCIER SITE REMEDIATION

PROJECT MGR: R. BOOTH **TEL: (416) 336-4589**

OBJECTIVE:

1) To develop and demonstrate technologies for the removal and treatment of dense non-aqueous phase liquids (DNAPL).
2) To complete the report on the aquifer remediation study and provide technology transfer for the benefit of other sites in Canada.

RELEVANCE:

The remediation of contaminated sites is extremely expensive and requires the application of efficient, site specific yet cost effective technologies. Many current remedial technologies need to be critically assessed and new and innovative technologies must be developed and demonstrated to resolve these problems. DNAPL is particularly difficult to remove from soil and fractured rock without excavation, which for deep contamination is cost prohibitive and for some sites impractical. In-situ technologies to dissolve DNAPL and increase its mobility so that it may be recovered for treatment are required.

WORK PLAN:

1) Complete the aquifer remediation study report.
2) Provide advice on the design of a DNAPL remediation experimental program.
3) Undertake the Scientific Authority duties for the DNAPL contract including chairing technical and management committee meetings, ensuring work is carried out in accordance with the contract, etc.
4) Review contractor's reports and provide comment.
5) Prepare technical presentations on the work done for poster sessions, technical papers, newsletter articles, etc.

STATUS REPORT - JUNE 1990

The rough first draft of the final report was prepared and sent to SNC and Sherbrooke for input.

A poster presentation for the TNO/KFK conference in December was prepared and the text forwarded to the conference organizers.

A briefing session and discussion on the project was held at WTC for André Marsan, the new ADM at MENVIQ responsible for Mercier.

STATUS REPORT - SEPTEMBER 1990

Comments on the first draft of the final report were received and revisions started.

On August 24, M. Halevy met with Pierre Gelinas, Laval University, to discuss the status of the hydrogeology component and the structure of the executive summary. It was agreed that a second meeting in October would be desirable to finalize the report completion schedules.

PROGRAM AREA: CONTAMINATED GROUNDWATER TREATMENT

PROJECT 68594: **NATO/CCMS PILOT STUDY - REMEDIATION TECHNOLOGIES**

PROJECT MGR: **J.W. SCHMIDT** **TEL: (416) 336-4541**

OBJECTIVE:

To access international information and expertise through NATO/CCMS on remedial action technologies for contaminated soil and groundwater.

RELEVANCE:

Contaminated soil and groundwater are a recognized serious environmental problem throughout Canada. Remediation efforts will cost many hundreds of millions of dollars over the next decade. Under the auspices of NATO/CCMS, a pilot study working group on the demonstration of remedial action technologies for contaminated soil and groundwater was established in 1987. The study will be complete in five years. The objective of the activity is to share knowledge and experiences as well as "lessons learned" on remedial action technologies between NATO participating countries.

WORK PLAN:

1) Participate in two yearly meetings of the Working Group on which Mr. Schmidt is the Canadian representative.
2) To disseminate information generated by the group to interested agencies and organizations throughout Canada.
3) To assist in the preparation of the final report of the Working Group.

STATUS REPORT - JUNE 1990

No significant activity.

STATUS REPORT - SEPTEMBER 1990

Planning for the November meeting to be held in Angers, France was initiated.

Copies of the Proceedings from the Oslo meeting were distributed.

PROGRAM AREA: CONTAMINATED GROUNDWATER TREATMENT

PROJECT 68595: **EVALUATION OF TREATMENT TECHNOLOGIES FOR CONTAMINATED SEDIMENTS**

PROJECT MGR: **R. BOOTH** **TEL: (416) 336-4889**

OBJECTIVE:

1) To develop, demonstrate and evaluate contaminated sediment treatment technologies which have potential for use on Great Lakes Areas of Concern.
2) To develop a Canadian centre of expertise and information for the treatment of contaminated sediments.

RELEVANCE:

Contaminated sediments pose one of the largest obstacles to the cleanup of the Great Lakes. There is a paucity of proven treatment technology for sediments worldwide. To date, most contaminated sediment remediation plans have involved dredging and disposal in confined disposal facilities (CDFs). There is a great deal of public opposition to the practice and the costs of CDFs are very high (and can be expected to increase with tougher regulatory controls and dwindling amounts of land available for facilities). Many promising technologies have been developed recently but are not yet proven for full-scale operation. WTC has been asked by the Great Lakes Environment Office of Environment Canada to lead the Sediment Treatment Technologies Work Group whose mandate is to evaluate the most promising new technologies. Funding for the program is being supplied by the Great Lakes Basin Cleanup Fund.

WORK PLAN:

1) Review and assess documented sediment treatment technologies.
2) Review, assess and select solicited and unsolicited proposals to develop and demonstrate cleanup technologies for Great Lakes sediment.
3) Provide contract and scientific authority services for funded development/ demonstration projects.
4) Establish and maintain an inventory and information base for contaminated sediment technology.
5) Provide guidance and information to the Great Lakes Working Groups (RAP teams), CDA committee and the Great Lakes Cleanup Fund.
6) Liaise and cooperate with other Canadian, U.S. and international committees and work groups working on contaminated sediment remediation or technology development.
7) Attend and make presentations at conferences and workshops related to contaminated sediment remediation.

STATUS REPORT - SEPTEMBER 1990

Arrangements for C. Wardlaw (EP-OR) to work at WTC as the Contaminated Sediments Treatment Coordinator were finalized and Craig started on August 9.

A four-year work plan for the program and a request for proposals for the demonstration of appropriate technologies are being prepared.

Several demonstrations of Ecologic's hazardous waste destruction unit were attended and reports prepared. Meetings and discussions were held with Ecologic to scope out laboratory

scale studies on Hamilton, Thunder Bay and Sheboygan sediment. Terms of Reference for the laboratory-scale experiments were prepared and a subsequent proposal by Ecologic reviewed.

C. Wardlaw attended a meeting of the US Assessment and Remediation of Contaminated Sediments (ARCS) Technical Working Group in Cleveland and a tour of the US/Kobe Steel Black River remediation project in Marion, Ohio. A tour report was prepared.

An ongoing dialogue is being maintained with Ontario Region, GLEO and WTC to discuss coordination of Great Lakes sediment activities.

PROGRAM AREA: MINING

PROJECT 68581: **GOLD MINING EFFLUENT TREATMENT**

PROJECT MGR: **A. ZAIDI** **TEL: (416) 336-4618**

OBJECTIVE:

1) To continue to collect and disseminate information on alternative technologies to treat gold mining effluents as well as undertake appropriate R&D to ensure that cost effective technologies are demonstrated for the treatment of gold mining effluents.
2) To provide technical advice and assistance to personnel from the C&P-Regions and IPB, industry and provincial and other government agencies, as required.

RELEVANCE:

The project is a continuation of the work from previous years and is designed to fill the knowledge/data gap in the application of alternative technologies to reduce the discharge of deleterious and toxic substances from gold mining and milling operations in Canada.

WORK PLAN:

1) Complete the production of a professional quality cyanide analysis training video (French language version).
2) Publish the reports on the performance of the Hemlo area gold mill effluent treatment systems.
3) Publish Equity Silver Mine report.
4) Complete and distribute natural degradation model.
5) Complete and publish the report on performance of the Hydrogen Peroxide process at 3 select gold mill sites.
6) Complete bench-scale study on recovery of cyanide by microporous gas membrane process.

STATUS REPORT - JUNE 1990

Hemlo Report

Review and editing of the report was completed and submitted to J. Hawley of the Ontario Ministry of the Environment.

SO_2/Air - Equity Silver Report

The tables and appendices were reorganized. A discussion of the QA/QC work was drafted and will be incorporated into the main report. The process and data presented in this report were reviewed for integration into Project 71's Expert System.

Natural Degradation

Possible methods of distribution of the computer model were discussed.

A preliminary draft of an introduction to the cyanide natural degradation model, CITAP, was completed. Documentation of the program code was initiated. This work will be continued in July.

H_2O_2 Report

The report entitled "Evaluation of the Use of Hydrogen Peroxide for the Oxidation of Cyanide in Gold Mill Effluents" was completed by WASTART Ltd. and submitted to the WTC. Technical reviews were performed; final review of the report by the Director, WTC, for distribution as an unpublished manuscript is still pending.

Cyanide Video

To date, 25 copies of the English language version of the training video for cyanide analyses have been sold.

Production of a French language video on cyanide analyses was put on hold until further notice with regard to funding. Vid Vid Video was identified as the producer for this video. French translation of the script and the brochure was completed by WTC staff.

The Use of Hollow Fibre Gas Membranes for the Recovery of CN From Gold Mill Effluents

Bench-scale work was continued on synthetic metal cyanide solutions. Actual waste barren solution was received for testing from Renabie Mine in Missanabie, Ontario.

Further modifications to the bench-scale set-up were discussed in which the membrane unit was combined with lime precipitation for metals removal in conjunction with cyanide recovery through the membrane unit into a caustic solution. Test work performed with actual wastewater samples from Bell Creek Mines was completed. Future work will include testing of Renabie's samples. Thiocyanate removal and the effect of copper on iron cyanide removal will also be investigated.

STATUS REPORT - SEPTEMBER 1990

SO_2/Air - Equity Silver Report

No significant activity.

Natural Degradation

A meeting between A. Zaidi, B. Jank and B. Ou was held to discuss future status of the computer model development and its use. B. Ou will explore options for its further development. For the present time, the model will not be distributed to non-Environment Canada parties although requests have been made by consultants for copies of this model.

H_2O_2 Report

Final review of the report by B. Jank for distribution as an unpublished manuscript was completed. Further modifications were suggested and are currently being made. The final draft should be completed by mid October.

Cyanide Video

The French language training video on cyanide analysis was completed and packaged by Vid Vid Video. The master tape and 10 duplicates were submitted to the WTC. The tapes will be sold through the CAWPRC. To date, 1 copy has been sold.

A Chinese translation of the tape is presently being considered.

The Use of Hollow Fibre Gas Membranes for the Recovery of CN From Gold Mill Effluents

Bench-scale experiments were completed and a review of cyanide recovery processes was conducted by K. Maracle as part of his graduate thesis work. Completion of a written report summarizing the results from this study is pending.

Desalination Report

Work was initiated by Cathy Gazzola and Taisto Viinikka (Co-op student from the University of Guelph) to complete and submit a polished draft of the freeze desalination report to the Ontario Ministry of the Environment.

To date, the figures from the main report and tables on equipment suppliers have been completed.

MISA monitoring data was received from the M.O.E. for completion of the Canadian Salt Co., Windsor, and Sifto Salt, Goderich, sections of the report.

Contacts with Michel Prudhomme (Energy, Mines and Resources), the American Salt Institute (Bruce Bertram), the U.S. Bureau of Mines (Denis Kostick) and The European Commission on Salt Studies (Bernard Moinier) were made with regards to an international salt mine listing and the status of environmental regulations for the salt industry in Europe and North America. Further contacts will include international embassies. Some literature is still pending.

UV Report (based on Trojan Study)

No significant activity.

PROGRAM AREA: MINING

PROJECT #596: **NATIONAL MINE ENVIRONMENT NEUTRAL DRAINAGE PROGRAM (MEND)**

PROJECT MGR: **D. VACHON** **TEL: (416) 336-4558**

OBJECTIVE:

Provide the Department's participation on technical committees under the National MEND Program and provide advice on remedial actions for reactive mine tailings and their discharges. Evaluate innovative treatment technologies for remedial actions for reactive mine tailings and their discharges.

RELEVANCE:

Reactive mine tailings can result in acid mine drainage generation which will have a serious impact on the environment. Effective neutralization and/or sealing of the tailings will reduce and/or eliminate acid mine drainage production. Potential measures to neutralize and seal reactive tailings include impervious ground covers and/or the establishment of a wetlands environment over the tailings.

WORK PLAN:

Specific activities to be undertaken in FY 1990/91 will include:

1) Provide advice and supervision to contract studies addressing appropriate treatment and/or remedial technologies.
2) Participate on technical committees of the MEND Program.
3) Assess applicability of potential new and innovative strategies for treating and/or remedial actions for reactive mine tailings.
4) Develop an experimental program to evaluate new and innovative technologies for treating reactive mine tailings.

STATUS REPORT - SEPTEMBER 1990

Preliminary discussions were held with IPB and CANMET personnel in late August to determine the logistics of transferring the program responsibilities from IPB to the WTC. No other significant activities have been conducted in this program area to date.

PROGRAM AREA: OIL AND GAS

PROJECT 6857B: **CHARACTERIZATION AND TREATMENT OF THE EFFLUENTS FROM EMULSION SHIPPING OF HEAVY OIL**

PROJECT MGR: **A. ZAIDI** **TEL: (416) 336-4618**

OBJECTIVE:

1) To characterize the effluents from the water-emulsion based heavy oil piping processes being developed by some oil companies.
2) To evaluate the treatability of these effluents on bench scale tests at the Wastewater Technology Centre and in the field.
3) To demonstrate the most cost-effective treatment technology at pilot scale in the field.

RELEVANCE:

Currently, the heavy oil produced in Alberta and Saskatchewan is pumped to the refineries as a mixture of naphtha and heavy oil. The use of naphtha reduces the viscosity of the oil and makes the pumping/piping of the heavy oil possible. Several oil companies (BP, Canadian Occidental, Shell, etc.) have developed techniques which will allow for the pumping/piping of the heavy oil as an oil-water emulsion/mixture. It is expected that the shortage of naphtha in the next three to five years will make these new techniques economically attractive for heavy oil transport, and that the refineries will have to treat substantial volumes of wastewater that will be generated when the oil is recovered from the oil-water emulsions/mixtures. Oil companies have requested assistance from the Wastewater Technology Centre to undertake the characterization/treatability work to minimize the environmental costs associated with the discharge of these wastewaters.

WORK PLAN:

1) Contact the relevant industry officials and review the available data to develop the sampling and analytical program.
2) Form a technical steering committee with representation by the relevant oil companies.
3) Arrange for the analysis of representative samples using the selected protocols.
4) Review the data and develop an experimental program for bench-scale treatability tests.

STATUS REPORT - JUNE 1990

The status of the work on oil emulsion piping of heavy oil was discussed with Dan Gillis of B.P. and Erdal Yildrim of CanOxy. Based on these discussions, it was decided to suspend all activities on this project until at least 1991-92. Further discussions will, at that time, be held with the Oil Industry to decide the course of future action.

STATUS REPORT - SEPTEMBER 1990

Based on discussions with both the two oil companies involved and internal discussions, it was concluded that this project should be cancelled and the funds reallocated.

PROGRAM AREA: OIL AND GAS

PROJECT 68580: **ON-LINE OIL-IN-WATER MONITORS FOR OFF-SHORE OIL PRODUCTION PLATFORMS**

PROJECT MGR: **A. ZAIDI** **TEL: (416) 336-4818**

OBJECTIVE:

The objective of this work is to evaluate available oil-in-water monitors which appear to be suitable for use on offshore oil production platforms. If necessary, an improved oil-in-water monitor may be developed to meet the specific requirements of this service.

RELEVANCE:

Discussions with the regulatory agencies and oil industry indicate that on-line oil-in-water monitoring will be necessary in the near future to ensure that the regulatory limits on the maximum permissible concentration of oil are not exceeded in the effluents from offshore oil production. There are several monitors available which are potentially suitable for this application; however; it is not known whether they can meet the necessary performance requirements. It appears that there may be a need to modify certain components of the available monitors to ensure acceptable performance.

WORK PLAN:

1) Assemble a database on available oil-in-water monitors.
2) Publish the information collected on available oil-in-water monitors.
3) Initiate experimental evaluation of selected oil-in-water monitors.
4) Review the experimental data from item (3) and determine the need for developing a monitor for offshore service. If necessary, develop a detailed plan for the construction of an appropriate monitor in 1991-92.
5) In parallel with item (3), conduct a laboratory study to evaluate alternative protocols for measuring oil & grease in oilfield brines.
6) Publish the results of item (5).

STATUS REPORT - JUNE 1990

Produced Water Characterization

Since the most commonly used solvent (CFC 113 or Freon) for oil & grease analysis will be phased out in the near future, a review was conducted to identify potentially suitable alternative solvents and to determine what solvents are being considered for this application by standards organizations. Over 15 organic solvents were identified that had been used or could potentially be used for this application. Contacts with the major manufacturers of chlorofluorocarbons (CFCs) indicated that they are all advocating the use of HCFCs as alternative solvents for oil & grease analysis. In the U.S., the EPA has proposed the use of hexane for oil & grease analysis and a final decision should be reached by October of this year. It is expected that the other major standards organizations (ASTM and AWWA) will be strongly influenced by the EPA decision.

Because of some concern that HCFC products may also be phased out because of their impact on the ozone layer, the work on oil & grease analysis with these solvents was not extended beyond the initial comparison of their extraction efficiencies with that of CFC 113.

Work is currently ongoing on the effects of produced water characteristics (pH, salinity and oil concentration) and silica gel treatment on determination of oil content using CFC 113 as the extracting solvent.

Oil-in-Water Monitors

In the last quarter, the manufacturers of the identified monitors were requested to verify the information collected in the WTC monitor database. Responses from all the manufacturers have been received and will be incorporated into the database.

A test program, recommending testing of 5 monitors at the Naval Engineering Test Establishment (NETE) in Montreal, was tabled at the June 21 meeting of the Technical Steering Committee. It was decided that a larger number of monitors (about 10) should be tested and that the criteria for selection of the test units and the details of the test program should be reviewed by personnel with relevant expertise within the oil industry.

An agreement has been reached with the Department of National Defense for the testing of the monitors at the NETE facility. DND has prepared a tasking order to NETE for construction of the test rig for the monitor evaluation. It is expected that the tests will be initiated in the fall of this year. DND estimates a cost of $100 - 120K and a 23-week duration for testing of 5 monitors.

STATUS REPORT - SEPTEMBER, 1990

Produced Water Characterization

Experimental work has been completed on the effects of produced water characteristics (pH, salinity, and oil concentration) on oil and grease analysis and on the isolation of the suspended oil fraction by treatment of the solvent extract with silica gel. Freon (CFC 113) was used as the extracting solvent for this work and the quantitation procedure used was IR spectroscopy. Work is now focused on interpretation of the experimental results generated to date in order to define the scope of further tests.

Oil-in-Water Monitors

Any new information received from monitor manufacturers and suppliers is continually being incorporated into the monitor database in order to keep it up to date.

A brief report was prepared and distributed to the Technical Steering Committee detailing the specific criteria used to select oil-in-water monitors for the test program. This information was reviewed by the committee members and a decision was reached at the July 31 meeting of the committee to proceed with the test work as originally proposed. This will involve testing of five oil content monitors: two light scatter units, the Shimadzu ET35 and the Schlumberger Oilcon; an IR absorption unit, the Optec Oili; a UV fluorescence monitor, the Sigrist photometer; and an ultrasonic unit, the Monitek. Additional oil content monitors may be evaluated after completion of this work pending further discussions with the Department of National Defense and the oil companies participating in the Technical Steering Committee.

The test work will be conducted by the Department of National Defense at the Naval Engineering Test Establishment (NETE) in LaSalle, Quebec. A sample of Terra Nova crude has been supplied to NETE for the test work. A one month test will be conducted on each unit. Final details of the monitor test program are now being resolved and the tests are expected to begin in late November.

PROGRAM AREA: OIL AND GAS

PROJECT 68582: **TREATMENT OF AQUEOUS EFFLUENTS FROM IN-SITU BITUMEN/HEAVY OIL RECOVERY**

PROJECT MGR: **A. ZAIDI** **TEL: (416) 336-4618**

OBJECTIVE:

To develop and demonstrate cost-effective technologies for the treatment of wastewaters from bitumen/heavy oil operations. Technologies will be such as to permit the recycling of wastewaters or surface water discharge.

RELEVANCE:

Produced water associated with the recovery of heavy oil by in-situ techniques contains a number of undesirable constituents. These are (1) emulsified and free oil, (2) dissolved toxic organics, (3) dissolved metals (4) suspended inorganic and organic solids, and (5) dissolved inorganic salts. Treatment of the "produced" water is required such that it can be recycled for steam generation, or discharged to surface waters. Efforts to date have been made to treat this water using demulsification techniques followed by a complex series of treatment processes to remove other undesirable constituents. Significant deficiencies have been identified in the technologies employed to date. In 1990/91, the focus will be on field testing and demonstration of electrodialysis for TDS removal and other processes.

WORK PLAN:

1) Finalize the characterization report on produced waters.
2) Reach agreement with Shell Oil and Esso-Cold Lake and initiate work at both sites for performance evaluation of their oil removal processes.
3) Initiate work at Amoco's Primrose Lake heavy oil facility on characterization; in particular, for silica.
4) Publish the executive summary report on the field evaluation of vapour compression evaporation.
5) Finalize the performance evaluation report on the operation of IGF units at the BP and Suncor plants.
6) Prepare a report on the bench scale field evaluation of electrodialysis.
7) Initiate work to pilot test electrodialysis in the field.

STATUS REPORT - JUNE 1990

AOSTRA/EC/Industry Produced Water Treatment Study

General:

Management Committee meetings were held in April and May. The main highlights for this quarter were (i) agreement to proceed with Part 2-Phase II was reached; (ii) a draft report of the Part 1-Phase II work was distributed for review and (iii) the overall pilot plant design was tabled.

Field Project:

Preparations for the Part 2-Phase II work began; specifically, the drawings for the pilot plant and the custom-made electrodialysis stack were drafted. Options and quotations for the equipment were obtained. Up to 7 plastics manufacturers were contacted with respect to suitable materials
of construction for the electrodialysis stack. Two manufacturers were selected to provide quotes and samples of final cell frame system for pressure tests.

The draft of the Part 1-Phase II report was completed. The contractors' reports on the ultrafiltration and microfiltration work were reviewed.

Characterization

The characterization report was reviewed and is being finalized.

TDS Removal

Membrane characterization work with actual produced water was completed and the data have been compiled. Further evaluation of the solid precipitate generated after microfiltration was carried out by University of Regina Energy Research Laboratory. Also, some samples were sent to the Energy Research Laboratory of Energy, Mines and Resources for further analyses.

STATUS REPORT - SEPTEMBER 1990

AOSTRA/EC/Industry Produced Water Treatment Study

General

No Management Committee meeting was held in this quarter. Amoco tentatively indicated that there would be a shutdown of its thermal heavy oil recovery operations. A paper titled "Recent Developments in the Treatment of Produced Water from In-Situ Heavy Oil Recovery" for presentation at the second Canada-China Heavy Oil Technology Symposium in Beijing, China was prepared by A. Zaidi and S. Kok.

Field Project

Preparations for the Part 2-Phase II work continued; specifically, tenders were reviewed and orders made for pH, conductivity, flow, pressure instrumentation and power supply. Information on tanks and heaters was collected.

Final design of the ED stack was completed; the cell frame designs were finalised with the selected plastics manufacturer. Final drawings were submitted to one supplier for manifold and spacing plates and cell frames with spacers and quotations received. Alternative methods for fabricating the cell frames are being investigated.

The appendices of the Part 1-Phase II report were completed; comments from the oil industry on the main report were obtained; the comments for revision of the contractor's reports on the microfiltration work were sent out to the contractor. The report on ultrafiltration by Zenon was sent out to the oil companies and AOSTRA. Revisions to the final report of Part 1- Phase 2 were incorporated.

Characterization

The characterization report was reviewed and is being finalized.

Oil and Suspended Solids Removal

Tests were initiated on a new ceramic microfiltration membrane by an outside contractor for oil and suspended solids removal from synthetic produced water. Several experimental membranes,
having different polymers cast on a base ceramic material, were tested. Work on the design of a flow cell apparatus for conducting bench-scale field trials was initiated.

TDS Removal

Membrane characterization work with actual produced water for the 300 days mark was completed. The solids analysis work by the Energy Research Laboratory of Energy, Mines and Resources in Ottawa continued.

The data from the membrane characterization work with actual produced water were compiled and reviewed.

PROGRAM AREA: OIL AND GAS

PROJECT 68583: **USE OF MEMBRANE TECHNOLOGY FOR THE REMOVAL OF OIL AND SUSPENDED SOLIDS FROM OILFIELD BRINE**

PROJECT MGR: **A. ZAIDI** **TEL: (416) 336-4618**

OBJECTIVE:

To evaluate the use of membrane technology (ultrafiltration and microfiltration) for the removal of oil and suspended solids from oilfield brines (produced water).

RELEVANCE:

Conventional technologies for oil and suspended solids (induced gas flotation and granular media filtration) cannot reliably remove these contaminants; therefore, a consistent water quality for recycle of the produced water for in-situ heavy oil recovery operations is not possible. Ultrafiltration and microfiltration may provide significantly better produced water quality in terms of oil and suspended solids.

WORK PLAN:

1) Review the status of ultrafiltration and microfiltration for removal of oil and suspended solids from produced water.
2) Provide support to IMRI, Ottawa on work related to the testing of membranes for oil and suspended solids removal from produced water.
3) Initiate work related to the use of dynamic membranes for oil and suspended solids removal.
4) Reach agreement with Amoco, Energy Mines and Resources and AOSTRA on a joint field study for evaluating microfiltration and ultrafiltration for oil and suspended solids removal.

STATUS REPORT - JUNE 1990

This project was initiated this year. A proposal has been prepared and negotiations between AOSTRA, Amoco, D and Environment Canada were underway to secure funding for the proposed work. Presentations were made at D's workshop on membrane technology for oily waste application. The proposal was sent to five oil companies.

STATUS REPORT - SEPTEMBER 1990

Negotiations between AOSTRA, Amoco, CANMET and Environment Canada continues with respect to funding for the proposed work.

PROGRAM AREA: OIL AND GAS

PROJECT 68589: **TREATMENT OF WASTEWATER FROM OFFSHORE OIL PRODUCTION**

PROJECT MGR: **A. ZAIDI** **TEL: (416) 336-4618**

OBJECTIVE:

The objective of this work is to evaluate alternative oil and suspended solids removal technologies which may be suitable for treating produced water from off-shore oil production/drilling facilities, and to develop/demonstrate the technology which may be most cost effective.

RELEVANCE:

Water produced during off-shore drilling and oil production contains significant amounts of oil and suspended solids. Usually, this water is discharged to the sea without proper treatment for oil removal. In some parts of the world (e.g. North Sea), the industry is being required to treat the water to remove oil and suspended solids. As off-shore drilling and production activity increases in Canada, the industry in this country will also have to provide proper treatment to the produced water. This work will assist the industry and the regulatory agencies in choosing the most cost effective technology for treating oily produced water from off-shore facilities.

WORK PLAN:

1) Organize and chair a technical steering committee composed of representatives from major oil companies, EMR and Environment Canada.
2) Complete status report on oil removal produced water treatment processes used on offshore oil production facilities.
3) Evaluate the performance of static and rotary hydrocyclones for removing oil from offshore produced water.
4) Publish the results of the tests on hydrocyclone technology.

STATUS REPORT - JUNE 1990

Hydrocyclones

A contract was set up with Professor Martin Thew of the University of Southampton for testing the oil removal efficiency of the CSPI Vortoil static hydrocyclone. A sample of Terra Nova offshore crude oil was supplied by Petro-Canada for this work. Test work was initiated in late June.

A proposal was received from Serck Baker, U.K. for testing of the Dynaclean rotary hydrocyclone. Total proposed cost was significantly higher than originally estimated and negotiations are underway to reduce the cost of the work.

Technical Steering Committee

Two meetings of the Technical Steering Committee were held in Calgary during this quarter. On April 4, representatives of Gulf and Mobil were brought into the meeting. A brief update of the status of all the project work was presented. Amoco, Petro-Canada, and Husky

confirmed their commitment to contribute to the project. Discussions with Mobil indicated that funding for the project would likely come from the U.S. office in New Orleans. Gulf will not actively participate in the project.

At the next meeting, on June 21, Memoranda of Understanding were distributed to the participating oil companies to facilitate the transfer of funds to the project. Arlene Hendrix of the Department of National Defense attended the meeting in order to participate in discussions regarding the monitor test program that will be conducted at a navy test facility in Montreal.

STATUS REPORT - SEPTEMBER 1990

Hydrocyclones

Tests of the CSPI Vortoil hydrocyclones are underway at the University of Southampton. The first phase of the work, which examined the effect of oil droplet size, oil concentration, water temperature and flowrate on oil removal efficiency, has been completed. The second phase, which will address the effect of contaminants on the hydrocyclone performance, will be initiated in October.

An engineer from Energy, Mines and Resources conducted a trip to the UK in August to supervise part of the hydrocyclone test work at Southampton.

A cost of $50,000 has been negotiated with Serck Baker, UK, for testing of the "Dynaclean" rotary hydrocyclone. A contract has been put in place with work scheduled to begin in November, 1990. The Dynaclean will be tested under the same conditions as those used for the Vortoil tests in order to allow a direct comparison of the two technologies.

Technical Steering Committee

A meeting of the Technical Steering Committee was held in Calgary on July 31, 1990. The meeting focused on a discussion of the Vortoil test program and was attended by Prof. Martin Thew of the University of Southampton.

A $50,000 contribution to the project was received from Energy, Mines & Resources and A Memorandum of Understanding was put into place between the WTC and both Husky Oil and Petro-Canada Resources.

A meeting was held with Mobil Oil personnel in New Orleans on September 13 to discuss the status of the offshore produced water treatment project. Mobil has agreed in principle to participate in the project and provide some funding but has not reached a decision regarding which branch of the company should be directly involved in the study.

Report, Papers, etc.

K. Simms attended the First International Symposium on Oil and Gas Exploration and Production Waste Management Practices in New Orleans from September 10 to 14 and presented a paper entitled "Alternative Processes for the Removal of Oil from Oilfield Brines".

PROGRAM AREA: METAL FABRICATION AND FINISHING

PROJECT 66576: TREATMENT OF METAL FINISHING INDUSTRY EFFLUENTS

PROJECT MGR: D. VACHON **TEL: (416) 336-4618**

OBJECTIVE:

Develop and demonstrate innovative, technically feasible and cost effective options for the treatment of effluents from the metal finishing industry.

Provide technical support to C&P-IPB and Regional Offices, other federal and provincial agencies and industry in resolving water pollution problems related to the metal finishing industry.

RELEVANCE:

Effluents from metal finishing operations are toxic and cause serious environmental problems. Current wastewater treatment technologies must be evaluated and new and innovative strategies must be developed and demonstrated to reduce this environmental hazard. The industry must be assessed with a view to developing "zero discharge" systems and processes.

WORK PLAN:

Specific activities to be undertaken in FY 1990/91 will include:

1) Continue to provide advice and supervision to a UP addressing the use of "Total Residual Chlorine" for process control of the alkaline chlorination process (2 stage CN oxidation). Completion March 31, 1991).
2) Evaluate current efficiency of treatment technologies for the metal finishing industry.
3) Assess applicability of potential new and innovative strategies for treating the industry wastewaters with a view to developing "zero discharge" systems. Develop a project proposal by December 31, 1990.
4) Provide technical support to C&P-IPB & Regional personnel, industry and others on related wastewater treatment problems.

STATUS REPORT - JUNE 1990

The pilot plant was decommissioned in early May. The staff of the metal finisher could not provide any effort in operating and monitoring the pilot scale facilities. As a consequence, very limited data were collected during the "non-intensive" portion of the demonstration phase.

The final report on the study is in preparation and is expected in early July.

STATUS REPORT - SEPTEMBER 1990

The draft edition of the final report was completed by WASTART on the study on process control of the alkaline chlorination operation in metal finishing plants. A preliminary review of this report has been conducted and a detailed review of the report was initiated.

PROGRAM AREA: METAL FABRICATION AND FINISHING

PROJECT 6857: **TREATMENT OF METAL CASTING INDUSTRY EFFLUENTS**

PROJECT MGR: **B. VACHON** **TEL: (416) 336-4558**

OBJECTIVE:

Develop and demonstrate innovative, technically feasible and cost effective options for the treatment of effluents from the metal casting industry.

RELEVANCE:

Effluents from metal casting operations can be toxic and can cause serious environmental problems. Current wastewater treatment technologies must be evaluated and new and innovative strategies must be developed and demonstrated to reduce this environmental hazard.

WORK PLAN:

Specific activities to be undertaken in FY 1989/90 will include:

1) Conduct a critical review of literature on current best available technology for treating effluents from the metal casting industry by March 31, 1991.
2) Evaluate the efficiency of current treatment technologies for the metal casting industry in Ontario.
3) Assess applicability of potential new and innovative strategies for treating the industry wastewaters.
4) Develop an experimental program to use bench-scale tests (sensitivity, optimization and simulation) and pilot scale development and demonstration studies to enable the implementation of BATEA at selected plants.

STATUS REPORT - JUNE 1990

No significant activities were undertaken in this project area this quarter. It is anticipated that only limited work will be conducted area until resources are identified to expand the scope of the program.

STATUS REPORT - SEPTEMBER 1990

No significant activities were under taken in this project area this past quarter.

PROGRAM AREA: METAL FABRICATION AND FINISHING

PROJECT 68579: TREATMENT OF IRON AND STEEL MILL EFFLUENTS

PROJECT MGR: D. VACHON

TEL: (416) 336-4558

OBJECTIVE:

Develop and demonstrate innovative, technically feasible and cost effective options for the treatment of iron and steel industry effluents.

RELEVANCE:

Effluents from iron and steel making operations can be toxic and can cause serious environmental problems. Current wastewater treatment technologies must be evaluated and cost efficient innovative strategies must be developed and demonstrated to reduce this environmental hazard.

WORK PLAN:

Specific activities to be undertaken in FY 1990/91 will include:

1) Complete by December 31, 1990 a critical review of literature on current best available technology for treating final mill effluents from the iron and steel industry.
2) Complete by March 31, 1991, an evaluation of the current treatment efficiency of waste treatment facilities for mills in Ontario.
3) Complete bench-scale tests and undertake pilot-scale tests to examine design parameters to achieve "model treatment" technology for final mill effluents by March 31, 1993.
4) Evaluate technical feasibility and economics for full scale implementation of appropriate technologies by March 31, 1993.
5) Assess requirements and develop and demonstrate innovative, technically feasible and cost effective options for the treatment of upstream process effluents from the iron and steel industry. Initiate in FY 1990/91.

STATUS REPORT - JUNE 1990

The draft Phase I Working Document was presented and discussed at the Technical Committee meeting on April 10, 1990. At this meeting, it was agreed that the initial study site for the WTC/MISA Filter study would be Dofasco.

During the last week in April, samples were collected from the "Flushing Liquor" feed to the Ammonia Still and the "Phenol Tank" discharge into the biological treatment plant. These samples were analyzed at the WTC for a number of conventional (pH, temperature, conductivity, solids, etc.), inorganic (anions, metals, cyanides, etc.) and organic (oil & grease, phenol, volatiles, etc.) parameters. Included in the chemical analyses were the identification and phase distribution of 16 PAH's. It was found that the majority of the total PAH concentrations were in the soluble form. Of the total PAH concentrations found in the two waste streams, the soluble fractions were 61% in the flushing liquor and 51% in the phenol tank discharge. Considering these data and data (supplied by Dofasco from their MISA pre-regulation monitoring) that showed significant concentrations of solids, cyanide, ammonia, and phenol in the biological treatment plant clarifier effluent, it was agreed with members of the Technical Committee (via telephone conference call -April 25, 1990) that the study site should focus on the clarifier effluent stream.

Bench scale testing was initiated in late May and studies are currently in progress. To date, preliminary testing has shown that waste pickle liquor (from Dofasco's pickling lines) is as effective a coagulant as $FeCl_3$. Furthermore, the addition of pickle liquor has resulted in some removal, by precipitation as "Prussian Blue", of residual iron cyanide found in the clarifier effluent.

Also completed to date, is the initial screening of sand sizes (0.8, 1.6) and loading rates (4 to 10 m^3/s) for indepth filtration. Further screening tests are in progress to assess coagulant dosages and the feasibility of dual media filtration.

STATUS REPORT - SEPTEMBER 1990

The Draft version of the Phase II Working Document was distributed and reviewed by members of the MOE/WTC Filter Study Committee.

Work continued on the construction of the mobile pilot scale filter facilities and on the computer process control algorithms required for this pilot plant. A roughing filter, ahead of the polishing filter, was found to be required for the treatment process and a unit was installed in the mobile pilot plant.

Work continued on the bench scale treatability studies evaluating filtration and pre-treatment requirements for the effluent stream from Dofasco's Biological Treatment Plant Clarifier. Tests were conducted to evaluate two-stage chemical addition designed to destabilize the solids present in the clarifier effluent. Adsorption tests were conducted to assess removal of phenol, ammonia and PAHs from the untreated clarifier effluent. It was found that waste pickle liquor can be used as an effective source of iron for the precipitation and subsequent removal of iron cyanide. In addition, the residual iron concentration from this precipitation step acted as the primary coagulant for solids destabilization. Polyelectrolytes were tested for their use as a flocculant aid to effect solids destabilization and removal by filtration.

D. Vachon continued his participation on the MOE-MISA and Iron and Steel Industry JTC (Joint Technical Committee) and BAT and DATA Evaluation subcommittees. D. Vachon continued to chair monthly MOE/WTC Filter Study Committee meetings to review and advise on the status of the program.

PROGRAM AREA: INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES

PROJECT 68572: TECHNOLOGIES FOR THE RECOVERY OF SPECIFIC CONTAMINANTS AND RECYCLE OF INDUSTRIAL EFFLUENTS

PROJECT MGR: A. ZAIDI TEL: (416) 336-4618

OBJECTIVE:

To ensure the availability of appropriate technology for recovering specific contaminants of concern from industrial effluents with emphasis on the recycle of treated effluents as process water. In 1990/91, the emphasis will be on organic chemicals.

RELEVANCE:

It is becoming more and more apparent that the use of effluent treatment technologies which transfer contaminants from one compartment (e.g. water) of the environment to another (e.g. air or land), is not providing adequate environmental protection. This work will identify and develop/demonstrate technologies which may be used for recovery and recycle of specific contaminants and wastewaters.

WORK PLAN:

1) Provide technical assistance/advice, as required to C&P-IPB and regional personnel, industry and other concerned agencies.
2) Maintain knowledge of the latest developments in toxics removal by adsorption, and develop improved techniques for evaluating the adsorption process on bench and pilot scale.
3) Review published information and contact relevant industry and government officials. Also, publish report on the work conducted in 1988-89 on the recovery and recycle of water in the food processing industry.
4) Complete a report on the opportunities and available technologies for the recovery and recycle of phenolics from industrial wastes.

STATUS REPORT - JUNE 1990

Several telephone discussions were held & letters exchanged between the DND and WTC staff to secure funding for the project. However, the funding is still not in place.

STATUS REPORT - SEPTEMBER 1990

No significant progress.

PROGRAM AREA: INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES

PROJECT 68573: TREATMENT OF PULP AND PAPER INDUSTRY EFFLUENT BY ULTRAFILTRATION

PROJECT MGR: A. ZAIDI

TEL: (416) 336-4618

OBJECTIVE:

The objective of this work is to evaluate ultrafiltration as a technology which may be suitable for treating wastewaters from the pulp and paper industry. More specifically, this work will focus (1) on the treatment of bleach plant effluents from kraft pulp mills, and (2) on the treatment of selected wastewaters from CTMP mills. The objective of the research would be to test, develop and demonstrate the effectiveness of the membranes for removing toxic organics from the wastewater. It is expected that the end result of this research would be patentable technical information on membranes for these particular applications.

RELEVANCE:

The effluents from pulp and paper mills represent a considerable problem for Canada. This is particularly true for the bleaching effluents from kraft mills as well as for CTMP effluents. Two major options are or could be implemented to reduce the toxicity of the effluents: a) modifications in the pulping processes and b) treatment of the effluents before discharge. It is highly probable that both ways would have to be implemented simultaneously in order to meet the impending stringent regulations. Ultrafiltration is an alternative external treatment to reduce or help in reducing the toxicity of the effluents, which has already gained popularity in some countries (Sweden, Japan...). This work will assist the pulp and paper industry of this country in evaluating ultrafiltration as a technique for wastewater treatment and in choosing the proper membrane/technology for these particular applications.

WORK PLAN:

1) Complete the initial membrane characterization and identify the membrane casting parameters which will likely provide a significantly better membrane;
2) Complete a draft report on the initial testing and evaluation of commercially available membranes for pulp and paper mill effluents;
3) Develop a detailed experimental program for studying effluent-membrane interactions;
4) Develop a detailed experimental program for final membrane evaluation and casting of a new membrane;
5) Complete an interim report on the study of ultrafiltration as a process to reduce the toxicity of selected pulp and paper effluents.

STATUS REPORT - JUNE 1990

Networking Activities

Technical meetings were set up with DuPont USA, Flakt Canada, NRC researchers, and researchers from Montreal on the treatment of pulp and paper industry effluents by ultrafiltration. Additional contacts were established with researchers from PAPRICAN B.C., the Alberta Research Council and U.B.C. as well as various researchers from Europe (Finland, France, Sweden).

Bench Scale Work at WTC

Technical information was gathered on various pieces of equipment necessary for our bench scale system.

Various drawings were proposed for the design of our plate and frame bench scale unit using a DDS LAB 20 module available to us. A configuration was chosen which will ensure greater flexibility for the system.

The equipment necessary for the building of our unit was ordered and most of it has been received. The work has started to put the parts together. The unit will be located in the pilot plant and initially tested with pure water.

An agreement was reached with Flakt Canada. This company will loan us a bench-scale CROT unit (Swedish Technology) for evaluation. Delivery is expected in July.

Contracted Work

1. World Industrial Membrane Corporation

   A three-month contract was raised with the World Industrial Membrane Corporation of Dr. Wang in Scarborough for the initial evaluation of the technology of dynamic membranes applied to selected pulp and paper effluents. The cooperative work officially started on May 15th. Two meetings were held on June 6th and June 21st to review the progress of the work. Initial data were gathered on fluxes and rejections using paper and ceramic materials chemically modified to produce suitable supports for the dynamic membranes.

2. Industrial Membrane Research Institute/University of Ottawa

   Dr. Sourirajan presented the initial results obtained in Ottawa on the characterization of commercially available polymeric ultrafiltration membranes. These results will be added to a state of the art review of the removal of toxics from pulp and paper effluents by ultrafiltration and presented in the 41st Canadian Chemical Engineering Conference in Halifax on the 20th of July. Technical problems on the carbon analyzer used to monitor the experiments slowed the work in June.

3. Electron Microscopy Unit/McMaster University

   The first membrane samples were sent to the E.M.U. for an initial evaluation of the preparation techniques for the membranes.

STATUS REPORT - SEPTEMBER 1990

Networking Activities, Papers and Presentations

A presentation was made by Abbas Zaidi at the 40th Canadian Chemical Engineering Conference titled "Evaluation of commercially available UF membranes for the removal of toxics from pulp and paper effluents".

Group members participated at ICOM 90 (Chicago, Illinois) and at the colloquium on "Microbial degradation of organochlorine compounds" at the Pulp and Paper Research Centre of the University of Toronto.

Technical work at the WTC

Preliminary tests were done on the CR-250 high-shear bench-scale unit, using three commercially available UF membranes.

Work on plate and frame bench-scale units to reproduce the preliminary results demonstrated by Dr Wang's team at the WIMC in Scarborough is ongoing. This work was delayed in September
in order to design and buy more suitable materials for the tests. A new work plan was finalized for this phase of the work.

Contracted Work

1. World Industrial Membrane Corporation

   Work is ongoing to further demonstrate the performance of new membranes in the treatment of pulp and paper effluents.

2. Industrial Membrane Research Institute/University of Ottawa

   Six new membranes were ordered to complete the preliminary characterization work being carried out by Dr Sourirajan. After our preliminary membrane studies, tests with real effluent, E-Stage, will be conducted.

3. Electron Microscopy Unit/McMaster University

   A presentation was made by Dr. Leppard of the work done on two Amicon membranes. These membranes will be characterized by Dr. Sourirajan's group to bring to the fore any relationship between structure and performance for these membranes.

PROGRAM AREA: INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES

PROJECT 68571: EXPERT SYSTEMS FOR THE SELECTION AND DESIGN OF INDUSTRIAL WASTE TREATMENT PLANTS

PROJECT MGR: A. ZAIDI

TEL: (416) 336-4618

OBJECTIVE:

To develop microcomputer based expert systems for evaluating alternative flowsheets and selecting the most cost effective effluent treatment system for a given industrial waste. This objective will be achieved through the development of expert systems for selected industrial sectors with gold mining being the first and in-situ heavy oil production being the second.

RELEVANCE:

The data, knowledge, and expertise necessary for selecting and designing the most cost effective waste treatment systems for some of the industries is dispersed in published literature and a few human experts. Therefore, it is relatively expensive and difficult to select the most cost effective waste treatment system for a specific situation. In some instances, the mistakes made during the selection and design phases can be very expensive. The availability of properly designed microcomputer based expert systems can minimize the cost and eliminate the errors. The development of such expert systems is now practical due to the availability of powerful microcomputers and necessary software at reasonable cost.

It is expected that the availability of the proposed expert systems will help both the regulatory agencies and the industry in achieving the desired effluent quality.

WORK PLAN:

1) Evaluate the currently available expert system shells for their effectiveness in the proposed project.
2) Develop custom software to enhance the user-friendliness of the proposed expert systems.
3) Assemble the relevant knowledge bases from published information and telephone interviews with selected human experts in the field of effluent treatment for Canadian gold mills.
4) Arrange for personal interviews with selected human experts and review the prototype knowledge bases for the purpose of enhancing their effectiveness.
5) Develop a plan for work to be conducted in 1991-92 on the expert system for the in-situ heavy oil production industry.

STATUS REPORT - JUNE 1990

To date, seven of the thirteen knowledge bases for treatment of gold mill effluent have been encoded into the expert system. The metals precipitation knowledge base was completed in June. A literature review of Inco's SO_2/air cyanide oxidation process was initiated for encoding the process into the next knowledge base.

A seminar on LEVEL 5 Object, the latest version of the expert system shell LEVEL 5, was attended in May. Contact was made with Rainer von Königslöw, president of COGNEX Inc., a consulting company based in Toronto and Ottawa, specializing in advanced expert system design and development.

A detailed summary of project 71's outline and work status was prepared. Review of the Level 5 Expert System shell was continued. The review included the natural degradation computer model, CITAP, for integration into Project 71's expert system.

STATUS REPORT - SEPTEMBER 1990

Preliminary coding of the knowledge bases for the GEMS1 prototype were completed (hydrogen peroxide, alkaline chlorination and SO_2/Air). Review of ozonation and acid volatilization regeneration (AVR) processes was also initiated.

Review of expert system shells was continued (i.e. Mahogany) and software for Level5 Object was received. A seminar on Level5 Object given by Infobuild Inc. in Toronto was attended by B. Ou and C. Gazzola.

An A.I. workshop and seminar held by DACAI was attended by B. Ou and B. Monaghan.

A meeting with A. Zaidi, C. Hill and B. Ou was held to review the status of GEMS1 and to further define the direction and focus of the expert system for the remainder of the 1990/91 fiscal year. Work was initiated to reorganize and refine the algorithm for the next GEMS1 prototype. It was decided that the prototype will incorporate the batch model of the natural degradation computer model. Development of the algorithm was started and will be encoded.

PROGRAM AREA: INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES

PROJECT 68574: OPTIMIZATION OF TERTIARY FILTRATION OPERATIONS

PROJECT MGR: D. AVERILL **TEL: (416) 336-4747**

OBJECTIVE:

The objective of this project is to optimize tertiary filtration operations in municipal wastewater treatment processes.

RELEVANCE:

Granular media filters are used as tertiary operations in the treatment of municipal wastewaters where high quality effluents are required. The filtration units are frequently designed using conventional parameters, including the filtration rates and media specifications, and they are generally operated without chemical aids. Recent studies have demonstrated that high-rate, in-depth granular media filters can be built and operated efficiently and produce high quality effluents. New methods of on-line instrumentation and control, such as the use of streaming potential measurement to control coagulant dosage, may be used to minimize chemical consumption and maximize the quality and/or quantity of the processed waters.

The need to improve effluent quality, and to operate treatment processes efficiently, has been emphasized in recent programs such as the Great Lakes Remedial Action Plans and the St. Lawrence River Program. An examination of current and alternative filter design and operating practices is warranted before proceeding with the application of conventional tertiary filter units to existing and new wastewater treatment processes.

WORK PLAN:

Year 1:
1. Conduct an assessment of existing filtration plant operation, (e.g. Dundas STP) by March 31, 1991.
2. Undertake filterability testing and an assessment of on-line instrumentation by March 31, 1992.

Year 2:
1. Design and construct pilot-scale facilities and conduct pilot scale optimization studies.
2. Undertake interim remedial action with respect to process modifications and full scale.
3. Develop process control strategies at pilot scale.

Year 3:
1. Undertake interim remedial action with respect to process control at full scale.
2. Demonstrate enhanced procedures at full scale.

STATUS REPORT - JUNE 1990

The objective of this new project is to examine and optimize the design and operation of granular media filters used as tertiary operations in municipal wastewater treatment processes. All work in this project is conditional upon external funding under the Great Lakes Remedial Action Plan Program. No work was undertaken in April or May. Planning for field work was initiated in June following notification of intent to fund the study.

PROGRAM AREA: INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES

STATUS REPORT - SEPTEMBER 1990

Planning for field work at the Hamilton-Wentworth Dundas Sewage Treatment Plant was continued. Study objectives were discussed with Region staff in July. A site visit was conducted and a detailed work plan was drawn up in August. Equipment selection and contract documentation were initiated. Work is expected to begin in October.

PROGRAM AREA: INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES

PROJECT 66575: PROCESS CONTROL AND UPGRADING OF EFFLUENT FILTRATION OPERATIONS

PROJECT MGR: D. AVERILL TEL: (416) 336-4747

OBJECTIVE:

1) To develop process control and monitoring strategies for granular media filters employed in either municipal or industrial wastewater treatment processes.
2) To develop a better understanding of filter design and operation procedures to refine the design of pilot scale and full scale filtration systems.
3) To optimise granular media filter systems for specific applications, including treatment of: municipal primary effluent; municipal secondary effluents (including enhanced phosphorus and trace contaminants removal); combined sewer overflows, and various industrial wastewaters, (e.g. mining wastewaters, produced water treatment).

RELEVANCE:

Granular media filtration is a solid/liquid separation operation used in the treatment of municipal and industrial wastewaters, the treatment of potable water, and in many industrial processes. Optimization of the many design and operational variables is a time-consuming task involving empirical procedures. Automatic control and data acquisition systems are essential to the improvement of design and operation methods. These systems will also improve mathematical modelling capabilities which will provide a better understanding of filtration mechanisms. The end product will be more efficient methods of designing and operating filters for specific tasks such as the removal of fine metallic precipitates from industrial effluents.

WORK PLAN:

1) Completion of the modelling work by March 31, 1991.
2) Develop a bench-scale filterability apparatus and procedures for incorporating process control, on-line data acquisition, modelling and an expert system user interface.
3) Technical assistance will be provided with respect to Project 79 (MISA, Iron & steel) and other projects as required.

STATUS REPORT - JUNE 1990

Part of this ongoing project is being undertaken in conjunction with the Department of Civil Engineering at McMaster University. The current objective is to examine and model the performance granular media filters such that filtration mechanisms may be identified and filter design may be based on a better understanding of the total system. The project includes two studies in this area: modelling of particle removal efficiency and modelling of headloss development. Data analysis and headloss model development were undertaken. Additional tests were conducted at bench scale. Work on the particle capture model was resumed. A presentation of the new modelling concept was made at the Fifth World Filtration Congress held in France in June. Final data analysis, the design of supplemental experiments and final report preparation for the particle capture study were initiated in June.

PROGRAM AREA: INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES

The development of a bench-scale procedure to be used for screening experiments in filtration process development programs was discussed at the CSCE Annual Conference in May; no written report or paper is available at this time. Preliminary results have indicated that a minimum bed depth of approximately 0.5 m is required and that run lengths will be sufficiently long as to necessitate process automation at bench-scale. Plans to build an automated bench-scale apparatus await confirmation of funding.

STATUS REPORT - SEPTEMBER 1990

The review of existing data, the design of supplemental experiments and final report preparation for the particle capture study were continued in this quarter. Additional pilot scale experiments were conducted for the headloss study.

PROGRAM AREA: **INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES**

PROJECT 68590: **OPTIMIZATION OF CHEMICAL PRECIPITATION COAGULATION AND FLOCCULATION OPERATIONS**

PROJECT MGR: **D. AVERILL** **TEL: (416) 336-4747**

OBJECTIVE:

1) Review flocculation theory and develop a predictive mathematical model.
2) Assess the impact of chemical precipitation and coagulation operations on the removal of contaminants from waters and wastewaters.
3) Investigate physical and chemical conditions which affect precipitation and coagulation operations and develop strategies for process optimization.
4) Optimize chemical precipitation and coagulation operations for the removal of phosphorus and other materials from municipal wastewaters.

RELEVANCE:

Chemical precipitation and coagulation operations are common to water and wastewater treatment processes. The efficiency of such processes is dependent on the physical and chemical conditions in the system. However, the hydraulic conditions in most full-scale plants are not conducive to optimum mixing and flocculation, and the traditional "jar test" procedures used for process design do not adequately model the system hydraulics. Ontario recently conducted a study of phosphorus removal, based primarily on monitoring full-scale plant performance with apparently little emphasis on fundamental design considerations. STPs discharging into Hamilton Harbour are considering sand filtration to improve treatment, but more cost effective methods may be realized by examining conditions within the plants. Quebec is implementing phosphorus removal in recently constructed and new plants; there is appreciable concern at the larger plants that optimum chemical usage be achieved. The removal of both organic and inorganic contaminants from water and wastewater would benefit from coagulation optimization and improved knowledge about the phase distribution of contaminants.

WORK PLAN:

A limited amount of work was accomplished in FY 1989/90. The work plan has been revised to emphasize the WTC/McMaster cooperative studies in the small particles program. This project will also provide a research basis for the support of other projects such as the Great Lakes Remedial Action Plans. The specific tasks are:

1) Conduct laboratory experiments and develop flocculation simulation models.
2) Conduct laboratory experiments to examine the fate of specific contaminants in precipitation and coagulation operations.
3) Conduct a literature review and bench-scale tests of precipitation, coagulation and flocculation operations to identify appropriate methods for the design and operation of chemical addition systems.
4) Examine the feasibility of employing new coagulants in wastewater treatment processes for enhanced process effectiveness.

PROGRAM AREA: INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES

STATUS REPORT - JUNE 1990

The objective of this ongoing project is to examine and model the dynamics of flocculation operations with reference to particle size distributions. The project is being conducted in conjunction with the Department of Civil Engineering at McMaster University. There are currently three studies: an examination of the dynamics of precipitate flocculation, the development of methods to monitor large flocs, and the development of an algorithm to simulate flocculation over the complete particle size range. Work on the precipitate study is nearing completion; a master's thesis has been submitted to McMaster University. The large floc study is in the exploratory stage; some observations have been processed by an automated image analysis system. A problem of numerical instability persists in the simulation algorithm but some success has been achieved with exploration of the effects of both small particles and large flocs in various simulation scenarios.

Flocculation observations and mathematical simulation results were presented at the CSCE Annual Conference in May. The in-situ monitoring study is continuing as a student project. Additional work must be done to address the problem of numerical instability in the models.

STATUS REPORT - SEPTEMBER 1990

The in-situ floc monitoring study is continuing as a student project. Testing of the new image analysis system was undertaken using samples from the flocculation experiments. A review of existing data, the design of supplemental experiments and final report preparation for the original flocculation modelling study were undertaken.

PROGRAM AREA: INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES

PROJECT 68591: OPTIMIZATION OF PRECIPITATION AND COAGULATION IN ACTIVATED SLUDGE TREATMENT PROCESS

PROJECT MGR: D. AVERILL TEL: (416) 336-4747

OBJECTIVE:

The objective of this project is to optimize the use of chemical coagulants in municipal wastewater treatment processes.

RELEVANCE:

Chemical agents are used to precipitate phosphorus in municipal treatment processes. Chemical addition also improves coagulation and the efficiency of solid/liquid separation operations. Optimized precipitation and coagulation will improve effluent quality in terms of precipitable matter such as phosphorus and heavy metals, suspended solids in general and surface-active toxic materials which are associated with particulates.

Previous studies have shown that chemical treatment operations may be improved by careful examination and control of residence time, mixing energy and dosages. Additional work remains to be undertaken with respect to instrumentation and process control options, and the integration of chemical and biological treatment.

WORK PLAN:

Year 1:
1) Conduct a chemical and hydraulic assessment of several existing treatment plants by December 31, 1990.
2) Conduct bench-scale process optimization and sensitivity testing by March 31, 1991.
3) Initiate an instrument evaluation program.

Year 2:
1) Undertake interim remedial action with respect to process modifications at a plant.
2) Develop process control strategies at pilot scale for application at a full scale plant.

Year 3:
1) Undertake interim remedial action with respect to process control.
2) Prepare a report with recommendations for full-scale remedial action to enhance the removal of phosphorus, suspended solids and other contaminants.

STATUS REPORT - JUNE 1990

The objective of this new project is to examine and optimize the use of chemical precipitants and/or coagulants in biological treatment processes. Interactions between the physical/chemical and biological components of the processes appear to be very complex and must be investigated in order to optimize the removal of phosphorus and suspended solids. The tasks included in the former Project 91 - Process Control of Coagulation - are included in the new program in addition to mixing optimization and interaction studies related to the combined phys/chem/biological treatment processes. All work in this project is conditional upon external funding under the Great Lakes Remedial Action Plan Program.

Project planning and preliminary monitoring work were undertaken by McMaster University personnel. A meeting was in May held between Halton Region, McMaster and WTC staff to discuss the results of preliminary sampling work and the proposed experimental program. A revised experimental program and proposal were prepared in June. Further action awaits confirmation of funding.

STATUS REPORT - SEPTEMBER 1990

Planning and contract preparation were undertaken for three studies at the Halton Region Skyway Wastewater Treatment Plant. A proposal submitted by McMaster University was used as the basis for a study which will include the assessment and optimization of chemical coagulation and phosphorus removal operations. Amendments to the existing process audit contract will include a hydraulic characterization study and an evaluation of the feasibility of on-line phosphorus monitoring.

PROGRAM AREA: TECHNICAL SUPPORT

PROJECT 68588: **TECHNICAL SUPPORT: C&P-HQ AND REGIONAL OPERATIONS**

PROJECT MGR: **J.W. SCHMIDT** **TEL: (416) 336-4541**

OBJECTIVE:

To provide technical advice and assistance to C&P-HQ and Regional personnel involved with resolving pollution problems in the following areas of concern:

1) cleanup of the Sydney, N.S. tar ponds
2) acidic drainage from mining operations and "acid slates"
3) International Joint Commission "areas of concern" and Great Lakes Water Quality Agreement activities
4) Fraser River Estuary projects
5) C&P-OR/MOE initiatives concerning source control of industrial effluents generally, (MISA)
6) C&P-QR and Centre St. Lawrence initiatives
7) WMD-IPB initiatives concerning hazardous waste management
8) C&P-NWR initiatives with respect to tailings ponds at tar sands plants

RELEVANCE:

Effective management of industrial wastewaters, particularly those containing toxic chemicals, is of concern to the Department.

WORK PLAN:

Provide technical advice, assistance and support as required to support relevant C&P activities.

STATUS REPORT - JUNE 1990

Drafts of the final MISA documents related to the definition of procedures for determining BAT were received and reviewed.

Jim Schmidt and Abbas Zaidi went to the EP-Atlantic Regional Office to review the program on the treatment of PAH contaminated wastewaters at the Sydney Tar Ponds site, to discuss the Divisional program with EP-AR staff and to visit the Sydney Tar Ponds site in Sydney, N.S.

Derek Vachon participated in the British Columbia Steel Task Force technical working sessions held from May 14 to 16 in Victoria.

A series of meetings were held with C&P-Ontario Region personnel as well as various stakeholders associated with the Hamilton Harbour Remedial Action Plan and other "areas of concern" to resolve the long-term funding of WTC projects under the Great Lakes Action Plan (Cleanup Fund).
Advice was provided to the Yukon District Office regarding water pollution control measures for the development of a new mine site.

PROGRAM AREA: TECHNICAL SUPPORT

STATUS REPORT - SEPTEMBER 1990

The Wastewater Technology Centre proposals for funding under the Great Lakes Action Plan (Cleanup Fund) were finalized and forwarded to the Great Lakes Environmental office in Toronto in July. Funding was received later in the quarter.

PROGRAM AREA: SLUDGE TREATMENT

PROJECT 68335: **ENERGY CONSERVATION: INTEGRATED SLUDGE MANAGEMENT SYSTEMS**

PROJECT MGR: **H.W. CAMPBELL** **TEL: (416) 336-4717**

OBJECTIVE:

To optimize energy usage at integrated sludge management facilities.

RELEVANCE:

Energy audits conducted on the sludge train have indicated that very significant energy savings can be expected through optimization of the sludge management train. The principle sludge unit operations can all be energy intensive and their correct coupling and optimization will effect significant energy and capital cost savings. Through optimization of the sludge train, it is anticipated that national annual energy savings of $8 to 10 million could be realized.

WORK PLAN

1. Develop conceptual approaches for optimization of energy usage at integrated sludge management facilities.
2. Initiate a contract and act as scientific authority.

STATUS REPORT - JUNE 1990

Available funding for 90/91 identified as $56K. A contract will be let to prepare state-of-the-art information and the terms of reference for the overall project. The annual meeting of PERD Task 1 in July will consider additional funding.

STATUS REPORT - SEPTEMBER 1990

A contract is being developed to identify the terms of reference and to provide assistance in the selection of the general contractor for the study. The scope of the initial contract includes identifying the current state-of-the-art instrumentation, conducting site visits in Canada and the U.S. to view in-place instrumentation and preparing the RFP to solicit proposals from qualified contractors. It is anticipated that the preliminary contract will be awarded by the end of October.

PROGRAM AREA: SLUDGE TREATMENT

PROJECT 68350: **DEMONSTRATION OF SLUDGE CONVERSION TECHNOLOGY**

PROJECT MGR: **H.W. CAMPBELL** **TEL: (416) 336-4717**

OBJECTIVE:

To oversee the performance evaluation of a 1 tonne/day demonstration conversion reactor system in support of the commercialization of the technology. Provide technical support to the licensee of the oil from sludge technology.

RELEVANCE:

The oil from sludge technology has progressed to the pilot validation phase and a 1 tpd unit is operating at the Hamilton STP. This phase of the program will assess both the technical and commercial viability of the technology. Support will be provided to the licensee to commercialize the technology as rapidly as possible.

WORK PLAN:

1. Operate the 1 tpd pilot plant to generate large volumes of oil for characterization and identification of end uses.
2. Operate the bench scale reactor system in support of the joint CANMET/SNC/WTC characterization program.
3. Support the licensee in the design and siting of the first full-scale demonstration plant.
4. Provide large volumes of oil to Still Otto, West Germany for the continuation of the diesel testing program.
5. Operate the pilot plant to determine design data for other potential full-scale applications.

STATUS REPORT - JUNE 1990

A meeting was held with Metro Toronto, SNC, ISTC and WTC on May 18 to finalize proposed funding for the demonstration plant. The Enersludge proposal will be presented to Metro Council at their July 4 meeting. H. Campbell met with the local Highland Creek ratepayers association to outline the proposed "oil from sludge" demonstration project.

Progress review meetings were held with CANMET on April 11 and May 30 to discuss the joint research program. Results on the options for end use of the oil continue to be promising. An indirect condensing system will be designed and installed on the pilot plant as soon as possible.

H. Campbell met with Still Otto, Bochum and E. Bayer, University of Tubingen to discuss the status of the OFS technology in Germany and Europe. Still Otto are proceeding with the design of a 10t/d pilot plant using rotary kiln technology.

STATUS REPORT - SEPTEMBER 1990

On July 4, Metro Toronto council gave approval to proceed with negotiating a contract with Enersludge to install an OFS facility at the Highland Creek Sewage Treatment Plant.

PROGRAM AREA: SLUDGE TREATMENT

WTC staff met with Ontario Region EP and ISTC on September 19 to discuss the respective roles of EC and ISTC and the timing associated with the EARP process for the Toronto plant.

Progress review meetings were held on July 25 and September 12 to discuss the joint CANMET/WTC/SNC program. Work is proceeding well and it is expected that two patent applications on novel end uses for the oil will be submitted by mid-October.

The design of the indirect condenser was finalized and is currently being fabricated.

Sludge was received from Houston's 69th Street and Almeida Simms plants. Characterization tests are in progress prior to initiating pilot plant runs.

PROGRAM AREA: SLUDGE TREATMENT

PROJECT 68352: **ENVIRONMENTAL ASSESSMENT OF SLUDGE CONVERSION TECHNOLOGY**

PROJECT MGR: **H.W. CAMPBELL** **TEL: (416) 336-4717**

OBJECTIVE:

To assess the impacts of combustion of the synthetic fuel produced by the oil from sludge technology.

RELEVANCE:

The sludge conversion technology developed at the WTC appears to have considerable commercial potential and may well form the basis for a significant portion of the future sludge management market. The technology is unique and the full potential environmental impact of this technology needs to be assessed.

WORK PLAN:

1. Under an unsolicited proposal submitted by Dearborn Environmental, an integrated process/analytical system has been constructed to permit assessment of PAH/HNC emissions from the sludge conversion process. Emissions from the combustion of the synthetic fuels produced by the oil from sludge technology will be assessed using this equipment.
2. Act as Scientific Authority on this contract.

STATUS REPORT - JUNE 1990

No activity due to illness of contracting personnel.

STATUS REPORT - SEPTEMBER 1990

Problems are still being experienced with the analytical system. A meeting was held with the contractor to identify support requirements for the rest of the year.

PROGRAM AREA: SLUDGE TREATMENT

PROJECT 68358: TECHNOLOGY TRANSFER: SLUDGE PROCESSING

PROJECT MGR: H.W. CAMPBELL TEL: (416) 336-4717

OBJECTIVE:

To maximize technology transfer in the field of sludge/residue treatment.

RELEVANCE:

In the past few years, major advances have been made in the development of new technology for sludge/residue treatment and the design of integrated sludge management systems. Much of this information is under-utilized due to the lack of suitable transfer mechanisms between researchers and users. Improved technology transfer can result in significant economic benefits to municipalities or industries.

WORK PLAN:

1. Continue participation in the Commission of European Community Treatment and Use of Sewage Sludge Program. Participation during 1990/91 will include a meeting of Working Party 1, Sludge Processing in Finland during June and a Workshop in Greece in October.
2. Provide technical assistance to develop, evaluate and/or promote new cost-effective sludge/residue treatment technology.
3. Actively promote the transfer of state-of-the-art residue treatment technology by participation at seminars, conferences and meetings of municipal officials or public citizens.

STATUS REPORT - JUNE 1990

H. Campbell attended a workshop and meeting of the EEC Working Party #1 "Sludge Processing" in Lappeenranta, Finland, June 17-19. Significant interest by specific European countries was expressed in ongoing WTC activities, particularly in the areas of solidification and soil remediation.

STATUS REPORT - SEPTEMBER 1990

No activity.

PROGRAM AREA: LAND APPLICATION

PROJECT 68337: **ORGANIC CONTAMINANTS IN MUNICIPAL SLUDGE APPLIED TO LAND**

PROJECT MGR: **M.D. WEBBER** **TEL: (416) 336-4519**

OBJECTIVE:

To develop and demonstrate technology with a view to promoting land application of sludge as an environmentally sound management practice.

RELEVANCE:

Roughly 40% of Canada's sludge is land applied and this utilization option supplies much needed nutrients and humus to agricultural soil. Satisfactory guidelines have been developed to make effective use of sludge nutrients and to manage the risks presented by pathogens and heavy metals. However, there are no guidelines to manage risks associated with organic contaminants contained in sludge. Continued technology development is required to obtain information on which to base organic contaminant guidelines for sludge use in agriculture.

WORK PLAN:

1. To conduct a program of sampling and analysis to obtain reliable organic contaminant information for selected Canadian municipal sludges.
2. Analyze soil samples taken from selected sites in Ontario and the U.S.A. which have received large applications of sludge for extended periods of time and from control sites, to determine whether the sludge has resulted in build-up of organic contaminants in soil.
3. To conduct laboratory and greenhouse studies on the fate of organic contaminants in municipal sludge applied to agricultural land.

STATUS REPORT - JUNE 1990

Mass balances calculated for soils from the last microcosm experiment with labelled anthracene indicated complete recoveries of ^{14}C. Much of the ^{14}C (70 - 95%) was retained in the soils and one-half to two-thirds of that retained was not extracted with hexane:acetone (41+59, v/v). Only traces of intact anthracene remained in the soils. These results indicated virtual complete degradation of the anthracene during the 19 weeks of the experiment and that most of the degradation products were incorporated into the soil organic matter.

A further microcosm experiment with several rates of ^{14}C-labelled anthracene, 4,4'-dichlorobiphenyl, 2,2',5,5'-tetrachlorobiphenyl and benzo(a)pyrene added to sludge treated Caledon soil is being initiated. The treated soil uncropped and cropped with ryegrass, soybean and cabbage will be analyzed at intervals to monitor contaminant persistence with time. In addition, ^{14}C recovery as CO_2 and volatile organics in the plant materials will be determined.

A draft report of experimental results to mid 1989 entitled "The Persistence of Selected Organic Contaminants in Municipal Sludge Applied to Land" was completed.

A paper entitled "Studies on the fate of organic contaminants in sludge treated soils" was presented to EEC Sludge Working Groups 4 and 5 meeting in Braunschweig, Germany, 6-8 June. In addition, M. Webber discussed organic contaminant buildup in soil and uptake by plants resulting from land

application of municipal sludge with Dr. H. Witte, Ste. Augustines, Germany.
Titles and abstracts were submitted for two poster presentations to be presented to the American Society of Soil Science annual meeting in San Antonio, Texas, October 1990.

STATUS REPORT - September, 1990

A microcosm experiment with several rates of ^{14}C-labelled anthracene, 4,4'-dichlorobiphenyl, 2,2',5,5'-tetrachlorobiphenyl and benzo(a)pyrene added to sludge treated Caledon soil has been initiated. The treated soil uncropped and cropped with ryegrass, soybean and cabbage is being analyzed at intervals to monitor contaminant persistence with time. In addition, ^{14}C recovery as CO_2, volatile organic and in the plant materials is being determined. The limited information available to date indicates that anthracene degradation is proceeding much as was observed in a previous experiment.

Analysis and interpretation of data obtained with 10 VOC and seven soils representing wide ranges of clay and organic carbon contents is in progress.

A report of experimental results to mid-1989 entitled "The Persistence of Selected Organic Contaminants in Municipal Sludge Applied to Land" is available.

A camera-ready copy of a paper entitled "Studies on the fate of organic contaminants in sludge treated soils", presented to an EEC Sludge Working Group meeting 6-8 June, was prepared for inclusion in the meeting Proceedings.

Soil samples from both corn and vegetable plots of the Chicago study have been received and are undergoing analysis. Results for priority pollutants in corn plot soils which received the highest rate of (1500 t ha^{-1}) of sludge application indicate <5 mg kg^{-1} dw of all compounds except bis(2-ethylhexyl)phthalate which occurred at about 75 mg kg^{-1} dw. To date, no PCB and pesticide analyses are available. Corn leaf samples were received in mid-September and preliminary PCB analyses are in progress.

PROGRAM AREA: LAND APPLICATION

PROJECT 68346: **TECHNOLOGY TRANSFER: LAND APPLICATION OF MUNICIPAL SLUDGE**

PROJECT MGR: **M.D. WEBBER** **TEL: (416) 336-4519**

OBJECTIVE:

To maximize technology transfer in the field of municipal sludge utilization.

RELEVANCE:

During the past several years extensive laboratory and field studies have been conducted to define optimal sludge treatment and utilization options. Much of this information is not extensively used due to the lack of suitable technology transfer mechanisms. Since major cost reductions are likely to be achieved by implementing the technology, dissemination of this information will be pursued by a variety of formats.

WORK PLAN:

1. Continue participation in the Commission of European Communities, Treatment and Use of Sewage Sludge Program. Participation during 1990-91 will include a German "Workshop on Organic Contaminants in Sludge", Braunschweig in June.
2. Promote transfer of best practicable sludge utilization/disposal technology by providing technical assistance to Federal, Provincial and Regional authorities and assisting with the organization of a biennial Canadian Workshop on Sludge Utilization on Land.
3. Serve as Environment Canada representative on the Agriculture Canada - Expert Committee on Soil and Water Management.
4. Serve as Environment Canada representative on the Ontario Soil Management Research Committee and on the joint Ministry of Agriculture and Environment Committee on Sludge and Waste Utilization.
5. Serve as a member of a group of about twelve agriculturalists reporting to US EPA concerning revision of the 503 sludge regulation.

STATUS REPORT - JUNE 1990

M. Webber attended a meeting of the Ontario Sludge and Waste Utilization Committee, April 23 at Guelph.

M. Webber discussed organic contaminant buildup in soil from sludge application May 10 and 11 with the City of Chicago. Subsequently, a proposal to study PCB, PAH and selected other organic contaminants in Chicago sludge, sludge treated soils and crops grown on the soils was prepared. Formal approval of the proposal was received from Chicago and the study will be conducted during July to December, 1990.

As Associate Editor of JEQ, M. Webber arranged for external review of two manuscripts and conducted detailed reviews of four manuscripts submitted for publication.

M. Webber reviewed an NSERC grant application concerning interactions of selected organic contaminants with soil components.

M. Webber reviewed a document entitled "Environmental Choice Draft Guidelines" on mulches and soil nutrient products for the Waste Management Branch of Environment Canada.

STATUS REPORT - September, 1990

M. Webber attended a meeting of the "Technical Advisory Committee -City of Winnipeg", July 19. The City of Winnipeg sludge dewatering facility began operation July 1 and the dewatered sludge is hauled direct to agricultural land for application. Storage in lagoons is being phased out and will occur only during the spring, summer and fall when field conditions are unsuitable for land application. The sludge will be landfilled during the period approximately December 1 to March 1. Nutrient and heavy metal research in relation to the land application program is proceeding satisfactorily.

M. Webber attended a land application of sludge meeting in Regina, July 24. The City are interested in land application as an alternative to landfilling. The City and Environment Canada conducted demonstration experiments in 1987 to 1989 and the City will continue experimentation through 1991.

M. Webber participated in a meeting July 22 in Penticton, B.C. to plan the 1992 annual meeting of the Canadian Society of Soil Science. The meeting will take place in Alberta and a scientific program committee consisting of people from that province was appointed.

M. Webber prepared a response to a Water Research Centre (UK) request for information concerning attitudes and perceived future needs for sludge disinfection in Canada.

PROGRAM AREA: LAND APPLICATION

PROJECT 68347: **LAND APPLICATION OF INDUSTRIAL WASTES**

PROJECT MGR: **H.W. CAMPBELL** **TEL: (416) 336-4717**

OBJECTIVE:

1. To determine the fate and treatability of industrial waste constituents through application to soil under a variety of environmental conditions and management practices.
2. To extend the available Canadian database regarding fate and treatability of waste constituents in soil through cooperation and transfer of expertise and technology with agencies in other countries.

RELEVANCE:

Appropriately managed, application of solid waste to land has potential as a cost effective method of waste treatment resulting in ultimate disposal for a number of Canadian industries. Currently, however, there is an insufficient database available regarding the environmental impact of a large number of organic and inorganic constituents of industrial wastes when applied to soil. The US EPA is currently developing an extensive database regarding degradation and transport of organic constituents of industrial wastes. A comparable Canadian effort is required to compile and expand upon the international database relevant to Canadian environmental conditions and to provide information required by Canadian managers for development of guidelines for land application of industrial wastes.

WORK PLAN:

1. Complete incubation study using mixtures of heavy oil wastes in soil to identify rates of degradation for target organic constituents with a variety of environmental conditions and management practices.
2. Compile results from microcosm studies to assess leaching, volatilization, degradation and plant uptake of target organic constituents, transport of inorganic constituents and toxicity of leachate under a variety of environmental conditions and management practices.
3. Participate in USEPA meetings to exchange information and technical expertise.
4. Provide technical advice and project review for PERD and other EC supported research in the area of industrial waste disposal.
5. Prepare a final report of project results.

STATUS REPORT - JUNE 1990

M. Webber prepared a liaison officer final report for NSERC concerning a Cooperative Research and Development Project entitled "Industrial waste through enhanced land treatment". The project was conducted at Guelph University under the leadership of Dr. R.P. Voroney and was supported by the Institute for Chemical Science and Technology.

GC/MSD analytical results for leachates from the Microcosm III Study are still pending.

The PERD interim report was submitted to T. Bulman and R. Scroggins for review and comments. T. Bulman has reviewed the report and her comments are presently being addressed.

Work continued on data base entry and statistical analyses of the experimental results for the final PERD report which is due in January 1991. T. Bulman and K. Hosler will meet on October 11 to finalize the format of the final report.

The Biometer Flask III experiment was initiated on May 29 with the spiking of flasks with ^{14}C-labelled 2-methyl-naphthalene. This study is scheduled to operate for 4 months. No ^{14}C-labelled degradation products have appeared to date. If no chemical degradation occurs within a few weeks, the flasks will be reinoculated or a nutrient solution will be added to enhance microbial activity.

STATUS REPORT - September, 1990

Data base entry and statistical analyses of the experimental results for the PERD final report is continuing. Linear regression analyses of the flask incubation study were completed, as well as interpretation of the toxicity testing results. Compilation of the results from the microcosm and biometer flask studies is continuing. Mass balance tables for the recovery of labelled chemical spikes in all three microcosm studies were completed. Calculations for the RITZ model input parameters are not yet complete due to delays in receiving analytical results and because the rationale for selecting appropriate chemical half-life values from the array of laboratory studies has not been finalized. T. Bulman and K. Hosler will meet in October to resolve this rationale and finalize the content of the final report. A six-month status report was prepared for submission to R. Scroggins during the October 24-25 PERD project meetings to be held at CCIW.

The Biometer Flask III experiment was completed. It was necessary to reinoculate the flask soils and add a nutrient solution during the experiment in order to enhance microbial activity. Analysis of flask soils for the ^{14}C-labelled target chemical and degradation products is expected to be completed by mid-October.

K. Hosler was invited to present a paper entitled "Assessment of risks associated with decommissioning industrial sites" at the Italian Instituto per l'Ambiente (Institute of the Environment) in January 1991. The first draft of the paper is being prepared.

An abstract entitled "The Persistence and Fate of Aromatic Constituents of Heavy Oil Production Waste Applied to Soil" was prepared by K. Hosler for presentation at the Canadian Petroleum Association/Environment Canada Environmental Research Technology Transfer Meeting to be held in Calgary on October 3-4, 1990.

Saskatchewan sludge samples and analytical results were sent to Agriculture Canada's Swift Current Research Station.

PROGRAM AREA: LAND APPLICATION

PROJECT 68354: **DEGRADATION OF CHLORINATED ORGANICS IN SOIL SYSTEMS**

PROJECT MGR: **H.W. CAMPBELL** **TEL: (416) 336-4717**

OBJECTIVE:

1. To develop an in-situ process for the biodegradation of pentachlorophenol using inoculants of microorganisms absorbed on granular activated carbon.
2. To develop an on-site process to leach pentachlorophenol from contaminated soil followed by biological degradation.

RELEVANCE:

Substantial quantities of soil contaminated with chlorinated organic compounds, including PCP's, are currently awaiting a suitable method for cleanup and disposal. Given the volume of soil involved, the potential for spillage during extensive transportation to incinerator facilities and the high cost of incinerating soil with a relatively low content of ignitable material, it is appropriate to explore alternative methods of treatment for contaminated soil. Microbial degradation by native soil organisms or selected PCP degrading strains in a controlled and contained incubation system may provide a cost effective solution which can be implemented on a contaminated site.

WORK PLAN:

Act as Scientific Authority for an unsolicited proposal submitted by Dearborn Environmental Inc. to develop unique processes which will effectively decontaminate soils containing toxic wood treatment chemicals (PCP's).

STATUS REPORT - JUNE 1990

Laboratory studies to assess rates of biodegradation of chlorophenols, PCBs and other toxic aromatic pollutants in soil continued.

The program to isolate and purify PCP-degrading bacterial strains continued. PCP and PCB degrading cultures were maintained.

A. Seech presented a research paper on "Biodegradation of Chlorophenols" at the annual Canadian Society of Microbiologists conference in Calgary.

STATUS REPORT - SEPTEMBER 1990

Laboratory studies on increasing the survival and activity of chloroorganic degrading bacteria continued. Determination of heavy metals in soils from wood preservation site was completed. Soil core studies on the influence of depth on biodegradation of PCP were initiated. Data analysis and preparation continued.

The program to isolate and purify PCP-degrading bacterial strains continued. PCP and PCB degrading bacterial cultures were maintained.

PROJECT 68348: MANAGEMENT STRATEGIES FOR MUNICIPAL SOLID WASTES

PROJECT MGR: T.W. CONSTABLE **TEL:** (416) 336-4716

OBJECTIVE:

To provide technical assistance and professional support with respect to ultimate disposal strategies for incinerator residues.

RELEVANCE:

Future management strategies for municipal solid waste and industrial hazardous wastes will include incineration technologies as a preferable alternative to landfilling. Preliminary characterization studies of these incinerator residues indicate that a significant proportion of the constituent heavy metals are highly mobile. Detailed evaluation of the residues is required to aid in developing regulatory criteria. Development of treatment technologies for ultimate disposal is also warranted.

WORK PLAN:

1. Provide support to the National Incinerator Testing and Evaluation Program (NITEP) by:
   a) conducting characterization studies on the residues from various types of municipal solid waste incinerators;
   b) assessing technologies for the immobilization of inorganic contaminants in these residues;
   c) providing general input to the NITEP program.
2. Coordinate efforts with the US EPA on research into incinerator residues and feasibility studies on immobilization technologies.
3. Support proposals that address incineration technologies.

STATUS REPORT - JUNE 1990

NITEP

Almost all of the laboratory testing on the solidified samples of ash from the Montgomery County facility and the untreated ashes from the Mid-Connecticut and Montgomery County facilities has been completed. Hydraulic conductivity tests on the Montgomery County solidified ashes are expected to be completed by mid-July.

Data from the characterization programs on the Montgomery County and 3M ashes are being compiled. The first draft of the report entitled "Characterization of Residues from a Two-stage Incinerator with Rotary Kiln (3M Canada)" is being written, and is expected to be completed by mid-July.

The report entitled "Characterization of Residues from a State-of-the-art Mass Burning Municipal Waste Incinerator (Burnaby, B.C.)" was published as an EPS Manuscript Series report in June. The report entitled "Evaluation of Solidified Fabric Filter Ash from a Mass Burning Municipal Waste Incinerator (Burnaby, B.C.)" is still on hold, awaiting the biotoxicity test results.

The second draft of the report entitled "Characterization of Residues from a Refuse Derived Fuel Combustion Facility (Mid-Connecticut)" was completed in April, and submitted to WMB and the US EPA for comments. The WMB comments were received in May and were incorporated into the report, but no comments have been received from the EPA.

S. Sawell presented a paper entitled "Ash Characterization Studies Under the National Incinerator Testing and Evaluation Program" at the Institute for Risk Research symposium entitled "Municipal Solid Waste Management: Making Decisions in the Face of Uncertainty" held in Toronto, April 25-27, 1990. The paper is to be published in the conference proceedings.

S. Sawell made a presentation on the NITEP Ash Characterization Studies at the First United States Conference on Municipal Solid Waste Management "Solutions for the 90's", in Washington, D.C., June 13 - 16, 1990.

A paper entitled "The National Incinerator Testing and Evaluation Program: Ash Characterization and the Implications of Disposal" was written and is being reviewed internally. The paper will be presented at GRCDA's 1990 Annual International Solid Waste Conference and Exposition to be held in Vancouver, B.C., August 20 - 24, 1990.

An abstract entitled "The National Incinerator Testing and Evaluation Program: Characterization of Residues from a Refuse Derived Fuel Incinerator" was accepted for presentation at the Third International Conference on Ash Utilization and Stabilization to be held in Washington, D.C., November 13 and 14, 1990.

STATUS REPORT - SEPTEMBER 1990

A. Chamberland and D. Hay from the Office of Waste Management and T. Constable and S. Sawell met on July 12 at the WTC to discuss the progress of the NITEP Ash Studies.

All of the laboratory testing on the solidified samples of ash from the Montgomery County facility and the untreated ashes from the Mid-Connecticut and Montgomery County facilities was completed. Compilation of data from the Montgomery County ash characterization studies is continuing.

The first draft of the report entitled "Characterization of Residues from a Two-stage Incinerator with Rotary Kiln (3M Canada)" was completed in July. After internal review, the report was revised and sent to the Ontario Ministry of the Environment and 3M Canada for review in August. The Ontario MOE's comments were received by the August 31 deadline, but none have been received from 3M Canada.

The report entitled "Evaluation of Solidified Fabric Filter Ash from a Mass Burning Municipal Waste Incinerator (Burnaby, B.C.)" was revised to include the biotoxicity test results, and is being reviewed internally.

The comments from the US EPA on the draft report entitled "Characterization of Residues from a Refuse Derived Fuel Combustion Facility (Mid-Connecticut)" were incorporated into the report. The revised draft report was sent to the Connecticut Resource Recovery Authority (CRRA) for review in August. A meeting or conference call is to be arranged by the Office of Waste Management to discuss CRRA's comments.

S. Sawell presented a paper entitled "The National Incinerator Testing and Evaluation Program: Ash Characterization and the Implications of Disposal" at the GRCDA's 1990 Annual

International Solid Waste Conference and Exposition held in Vancouver, B.C., August 20 - 24, 1990.

S. Sawell attended an meeting of the WASCON '91 Conference Organizing Committee, September 13 - 14, at ECN in Petten, Netherlands. S. Sawell and C. Wiles (US EPA) were given the responsibility of selecting 25 abstracts for presentation in one of the sessions.

PROGRAM AREA: WASTE CHARACTERIZATION

PROJECT 66556: **EXPERT SYSTEM FOR ASSESSING SOLID WASTE LEACHING AND DISPOSAL**

PROJECT MGR: **T.W. CONSTABLE** **TEL: (416) 336-4716**

OBJECTIVE:

Develop a comprehensive and user-friendly software program to assist in assessing the leachability and disposal of solid wastes (excluding municipal refuse). The program will combine (1) an expert system, (2) a landfill model to simulate leaching under various disposal conditions, and (3) data bases on known waste properties and leaching characteristics under different leaching test conditions. It will assist in the development of waste disposal scenarios, input of data to the landfill model, recommending laboratory tests, and interpreting laboratory and simulation data with respect to waste leachability, leachate treatment and waste suitability for landfill disposal.

RELEVANCE:

Increased concern over the environmental impact of solid waste disposal has necessitated use of a wide variety of bench-scale leaching protocols to estimate leachability under various disposal scenarios. However, this approach is very expensive and time-consuming. An alternative approach is to combine available expertise on waste leachability as rules in an expert system with a landfill model and databases on waste characteristics, to cost-effectively simulate and measure leaching under a wide range of conditions with a reduced level of bench-scale testing.

WORK PLAN:

1. Provide technical expertise to Dearborn on the knowledge base (rules) structure of the expert system.
2. Compile a data base on chemical and leaching characteristics of coal combustion fly ash.
3. Develop a prototype expert system to guide a user through batch leaching protocol testing and evaluation of landfill disposal options for fly ash.
4. Incorporate the landfill simulation model into the program, and develop an expert system rule structure to interpret the results of this model.
5. Demonstrate the prototype expert system to potential end-users, obtain feedback and incorporate suggestions.
6. Expand the data base and knowledge base to allow assessments of a wide range of solid waste types.
7. Act as Scientific Authority on the contract.

STATUS REPORT - JUNE 1990

A meeting of the Technical Steering Committee was held at Dearborn on April 18.

A paper entitled "Development of an Expert System for Assessing the Leaching and Disposal of Solid Waste" was presented at the CHS-90 Symposium on Expert Systems and Statistical Methods in Water Resources, May 29, at the Canadian Centre for Inland Waters.

Work is continuing on development of the expert system knowledge base.

STATUS REPORT - SEPTEMBER 1990

D. Young of Dearborn and T. Constable attended The Third International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, July 15-18, in Charleston, South Carolina, and the Fourth AIRIES Workshop on Artificial Intelligence Applications in Environmental Science, Sept. 24-27, in Val Morin, Quebec.

Work is continuing on development of the expert system knowledge base.

PROGRAM AREA: WASTE SOLIDIFICATION/STABILIZATION

PROJECT 68345: ASSESSMENT AND DEMONSTRATION OF STABILIZATION/ SOLIDIFICATION TECHNOLOGY

PROJECT MGR: T.W. CONSTABLE TEL: (416) 336-4716

OBJECTIVE:

1. To evaluate the applicability of existing processes to new waste streams.
2. To assess new solidification processes from a mechanistic point of view.
3. To use a modelling approach to predict leaching of solidified wastes in a field environment.
4. To promote the use of stabilization/solidification as a final treatment process for the disposal of hazardous wastes.
5. To demonstrate the use of the "Proposed Protocol" to identify appropriate disposal scenarios.

RELEVANCE:

Solidification is a relatively new technology. The WTC is promoting the use of an assessment protocol based on measurement of physical, engineering and chemical properties to identify appropriate disposal scenarios.

WORK PLAN:

1. Co-operate with users of the technology to assess the suitability of commercial processes and various disposal scenarios.
2. Provide support to the OWMC in the development of technology for the proposed hazardous waste treatment facility.
3. To identify a site and develop a joint agreement with the proponent and other government agencies to demonstrate the use of the "Proposed Protocol".

STATUS REPORT - JUNE 1990

R. Caldwell, T. Constable and A. Pepper attended the ASTM Second International Symposium on Stabilization/Solidification of Hazardous, Radioactive, and Mixed Wastes, from May 29 to June 1, in Williamsburg, Virginia. T. Constable attended a meeting of the ASTM D-34 Committee on Waste Disposal, in Williamsburg, Virginia, from June 4 - 6.

Optimization of Organic Contaminant Containment in Solidified Wastes

Comments on the Draft report from OWMC and their consultants have yet to be received.

Test Methods

The "Compendium of Waste Leaching Tests" has been published and is available for distribution.

Comments of the "Proposal Evaluation Protocol for Stabilized/Solidified Wastes" have been received and are being incorporated into the document.

Development of an Accelerated Extraction Test

The second draft of the report entitled, "Development of an Ultrasonic Agitation Method for Waste Extraction Tests: Phase I" has undergone internal review and has been distributed for review to the agencies which provided funding.

Salt Migration Through a Clay Bed

Samples of solidified batches of the low and high Cl ash residue have been evaluated to determine the rate of diffusion of the metals and anions of interest using the ANSI/ANS 16.1 protocol. The columns which have been scheduled for use with the high chloride ash residue have yet to be constructed due to problems encountered in formulating a self sealing/self healing barrier.

A meeting was held at WTC with researchers from McMaster University to discuss the problems impeding the selection of a SS/SH barrier formulation. Once a formulation is selected the solidification of the high chloride ash residues within the columns will take place.

R.J. Caldwell met with P.L. Côté of Zenon and C.C. Chao of OWMC on April 30, 1990 to discuss work to be done by WTC for OWMC over FY 90/91. R.J. Caldwell presented three draft proposals for discussion. Namely:

1. Column Test Monitoring for the Evaluation of Salt Migration Through a Clay Bed.
2. Accelerated Testing of Solidified Residues.
3. Engineering Properties Testing of Solidified Residues.

The proposals were altered to account for changes suggested during the meeting and re-submitted for financial support. WTC was informed that the proposals were accepted during the last week of May, 1990 and work began immediately.

Column Test Monitoring for the Evaluation of Salt Migration Through a Clay Bed

This project is a continuation of the previous years work in the area. WTC will "monitor" the columns prepared in FY 89/90 under a renewable 1 year contract.

The columns were solidified on March 20, 1990 and have remained in darkness (to prevent photodegradation) at room temperature. The water within the column was spiked with sodium azide to prevent biodegradation. A small amount of white solid was observed on March 30, 1990 to be forming in the small vacuoles along the column wall (caused by shrinking of the waste form during curing). It is hypothesized that this material is calcium carbonate. Although the amount of white precipitate is small, its quantity continued to increase (most notably at the back of the column closest to the wall) until May 11, 1990 when equilibrium seemed to be achieved. There has been little to observe since that time. Several leaks had developed over the first several weeks after start-up, but were quickly repaired. The amount of leakage was small and only noticeable by the appearance of sodium azide crystals at the bleed plugs. Water levels in the columns were re-established.

Accelerated Testing of Solidified Residues

The objectives of this project are to:

1. Investigate the potential of high temperature curing.
2. Evaluate the potential of indirect or accelerated methods for estimating physical strength and leachability.

3. Correlate the properties of specimens cured under accelerated conditions to those cured under normal conditions, and
4. Correlate the results of accelerated tests to selected performance tests.

Selection of the three cementing formulations required for the study have been completed using chrome plating residues already in WTC's possession. A series of small batches of the residue were solidified, cured and tested for UCS in order to select the Portland cement dosages required to obtain cured UCS values of approximately 500, 5000 and 15000 kPa. The chemicals required to spike the formulations with lead, arsenic, phenol, lithium and chloride have been obtained.

Engineering Properties Testing of Solidified Residues

The general objective of this project is to investigate the effects of formulation and curing time on engineering property development of solidified residues.

Approximately 160 L of a hard chrome (3+) sludge was obtained from a local plating operation. The same supplier has been used previously for OWMC studies, however, a new technician has been operating the equipment with visual improvement in chrome (6+) reduction. Slightly different quantities of precipitating and flocculating agents should be found during characterization. The other two wastes cannot be prepared until a sample of HIM salt/ash has been received from Biebesheim, FRG. Solidification and identification of cementing formulations has been completed using chrome plating and salt/ash residues left over from FY 88/89 and 89/90. Also, small preliminary batches have been used to optimize the testing methods and testing schedule while gaining insight into the curing rates of the selected formulations.

STATUS REPORT - SEPTEMBER 1990

Cooperative Project: Investigation of Test Methods for Solidified Waste Evaluation

The final version of the report, "Investigation of Test Methods for Solidified Waste Evaluation - A Cooperative Program", is in Ottawa undergoing the process of publication.

Protocol: A Proposed Protocol for Evaluation of Solidified Wastes

Comments received from reviewers and the funding agencies were incorporated in a final draft of the protocol which is currently undergoing finalization at WTC, prior to publication. J. Stegemann made a presentation of the protocol at the September meeting of the Air and Waste Management Association in Orillia.

OWMC Project: Optimization of Organic Contaminant Containment in Solidified Wastes

Comments on the Draft report from OWMC and their consultants have yet to be received.

Method Development: Development of an Accelerated Extraction Test

The second draft of the report entitled, "Development of an Ultrasonic Agitation Method for Waste Extraction Tests: Phase I" is currently undergoing review by the agencies which provided funding.

Column Test Monitoring for the Evaluation of Salt Migration Through a Clay Bed

This project is a continuation of the previous years work in the area. WTC will "monitor" the columns prepared in FY 89/90 under a renewable 1 year contract.

A formulation for the self sealing/self healing (SS/SH) barrier was supplied to WTC by McMaster University researchers during the second week of July. The last four columns were solidified on July 10, 1990 and have remained in darkness (to prevent photodegradation) at room temperature. The water within the column was spiked with sodium azide to prevent biodegradation. Several of the columns were equipped with stainless steel electrodes for conductivity measurement.

The conductivity apparatus has been calibrated for initial measurements and cell constants have been calculated. The data from weekly conductivity measurements are being expressed graphically in order to monitor progression of the saline front. The profiles which are developed generally show a smooth "s" shaped curve sloping down from the high conductivity zone within close proximity to the S/S residue to the low background conductance level of the zones to which the salts have not yet diffused. Several small leaks developed in the lower column of column #4 but were easily repaired.

Samples of the clay from each of the 8 original shelby tubes have been extracted and analysed to establish background contaminant concentrations within the undisturbed clay samples. Distilled water extractions were used for anions and total acid digestions were used for cations. This data will be required when columns are harvested annually for destructive analysis.

Accelerated Testing of Solidified Residues

R.J. Caldwell held a meeting at WTC with Richard Keir of Mandel Scientific in order to research the methods available to monitor the exact ultrasonic power input supplied during ultrasonic extractions, however, he was informed that the power monitors are not adaptable to a two probe ultrasonic agitation system. If WTC is to use this equipment we will be required to run with a single probe, thereby doubling the required testing time. The possibility of employing rosette cells to allow mixing of leachant with residue without magnetic mixers was also discussed. It was determined that rosette cells are available only in volumes of 250 mL or less, therefore extractions would be conducted on smaller volumes (250 mL rather than 500 mL). Also, the use of rosette cells will allow the addition of rubber gaskets, sealing the extraction vessel, and limiting the flux of CO_2.

Engineering Properties Testing of Solidified Residues

Approximately 160 L of a hard chrome (3+) sludge, obtained from a local plating operation, has been dewatered to a moisture content of 60%. Small preliminary batches were used to optimize the testing methods and testing schedule, while gaining insight into the curing rates of the selected formulations. Unconfined compressive strength (UCS) and Vicat Needle measurement techniques were employed in order to determine the development of physical integrity over time for the hard chrome sludge solidified using five different formulations.

The other two wastes to be investigated will be prepared from a sample of HIM salt/ash recently received from Biebeshiem, FRG. This new sample of HIM ash is visibly different from other, previously obtained samples as the installation of new scrubber systems has introduced lime to the ash changing its colour and increasing its pH. A representative sample of the ash is currently undergoing a complete physical and chemical characterization.

Pretreatment of the "new" HIM ash was carried out in the same manner as the "old" HIM ash during FY 89/90, as similar amounts of lime were required to alter the slurry pH to 9.5, even though the "new" ash initially formed a solution with a slightly higher pH. The resulting sludge was used to prepare five batches with different cement-to-ash ratios. UCS and Vicat Needle measurement techniques were used in the same manner as used on the hard chrome sludge. The results have been interesting in that, after an initial period of slow curing (possibly ettringite formation), they then cure quickly. The initial period generally seems to be several days. The hard chrome sludge did not show this behaviour.

PROGRAM AREA: SITE REMEDIATION

PROJECT 68357: **INDUSTRIAL SITE DECOMMISSIONING**

PROJECT MGR: **T.W. CONSTABLE** **TEL: (416) 336-4716**

OBJECTIVE:

1. To provide technical data and expertise for establishing cleanup criteria for decommissioned industrial sites.
2. To evaluate models which describe the transport of chemicals from the unsaturated zone of soil to routes of human and environmental exposure.

RELEVANCE:

In workshops sponsored by Environment Canada to identify concerns regarding decommissioning of industrial sites, the most critical issue was generally considered to be the determination of cleanup criteria, i.e., "how clean is clean". Various methods for setting cleanup criteria are available, but in many cases do not take into consideration site specific criteria, particularly those concerning transport from contaminated media (usually surface soil) to human and environmental exposure pathways. In 1987 work was initiated to develop a scientifically supportable method for determining site-specific cleanup criteria which combined risk assessment, pathways analysis. A computer model was developed, the Aid for Evaluating the Re-development of Industrial Sites (AERIS).

WORK PLAN:

1. Provide liaison between Environment Canada and U.S. EPA in studies which evaluate methods of determining cleanup criteria.
2. Complete the final report entitled "Field Evaluation of the Regulatory and Investigative Treatment Zone (RITZ) Model".
3. Commercialize the AERIS expert system.

STATUS REPORT - JUNE 1990

T. Bulman is currently reviewing and writing portions of the final reports. Discussions were held with several interested parties about commercialization of the AERIS expert system. Proposals to licence the technology were requested by CPDL by July 13.

STATUS REPORT - September, 1990

T. Bulman's contract was extended in July to provide additional time for preparation of the report entitled "Field Evaluation of the Regulatory and Investigative Treatment Zone (RITZ) Model - Volumes 1 & 2". In August, she was sent the U.S. EPA's comments on the previous draft of the report and a complete set of compiled data from the two years of field research for inclusion in the report.

K. Hosler and T. Bulman are to meet with J. Matthews of the U.S. EPA on Oct. 3-4 to finalize the contents of the report.

PROGRAM AREA: SITE REMEDIATION

PROJECT 68358: **VOLATILE ORGANICS CONTROL IN INDUSTRIAL WASTE STREAMS**

PROJECT MGR: **H.W. CAMPBELL** **TEL: (416) 336-4717**

OBJECTIVE:

1. To investigate the use of pervaporation for the removal and concentration of VOC's from water.
2. To develop a pervaporation membrane.
3. To develop a pervaporation module.

RELEVANCE:

Many hazardous waste streams contain VOC's which can be emitted to the atmosphere during waste storage, treatment, and disposal. One way to minimize or eliminate these emissions is to pretreat hazardous wastes to remove these compounds.

WORK PLAN:

1. A bench-scale unit will be used to test various membranes and waste feeds.
2. Under a U/P from Zenon Environmental Inc. a pervaporation membrane and module will be developed. Performance testing will take place at the WTC.
3. Act as scientific authority and liaison with EPA re: SITE program.

STATUS REPORT - JUNE 1990

Analytical methods using head-space analysis for estimation of TCE concentration in water have the greatest reproducibility and will be used as the method of analysis. The Quality Assurance Project Plan for EPA commenced.

It was agreed by all parties that the pervaporation unit built by Zenon for the River Road Facility, will be left at WTC for testing purposes for the remainder of the project. Sizing and some purchasing of equipment for the preliminary testing using the Zenon pilot plant commenced.

At the SITE (E.P.A.) program in Philadelphia, a WTC poster was presented introducing pervaporation as a method of VOC removal from wastewater. The Year 1 Summary and Year 2 Narrative Statement were completed for the SITE Emerging Technology Program. The proposal for continuation of funding under the SITE program for Year 2 was submitted to the EPA grants officer.

System and membrane requirements continued. Mono-layer module construction commenced.

STATUS REPORT - SEPTEMBER 1990

The Quality Assurance Project Plan for EPA was submitted to EPA for review.

Membrane coatability trials have narrowed the number of suitable silicones from seven to one. The silicone coating technique will be optimized for this one silicone. Two newly developed silicone rubbers may be tested in the future.

Modules suitable for coating (and subsequent pervaporation testing) have yet to be constructed.
Modification of the Zeton Pilot to accept new pervaporation modules is 80 % completed.

PROGRAM AREA: SITE REMEDIATION

PROJECT 68359: ENGINEERED BARRIERS FOR WASTE CONTAINMENT

PROJECT MGR: H.W. CAMPBELL TEL: (416) 336-4717

OBJECTIVE:

1. To evaluate the effectiveness of natural and synthetic material liners to contain wastes.
2. To develop an engineered barrier that minimizes the rates of leaching from landfills, waste impoundments, lagoons, etc.

RELEVANCE:

Past work on waste leachability estimation and on solidification has illustrated the potential for groundwater contamination from various liquid and solid wastes stored or disposed on land. This problem can be alleviated through the use of engineered barriers or liners. There is a need to evaluate the long-term migration rate through various natural and synthetic material engineered barriers. In addition there is a need to develop engineered barriers with low migration rates, flexibility and long life.

WORK PLAN:

1. Through a U/P with McMaster University (Dr. J. Kramer, Geology), develop a new barrier based on a propriatary WTC concept.
2. Under the co-operative agreement with ECN, develop a model of contaminant transport at interfaces and through engineered barriers.

STATUS REPORT - JUNE 1990

Recipes for the liner for the OWMC chloride retention study were finalized. Experiments on scale-up to 20L bottles were initiated. Techniques using dye tests to moniter leakage of the tracer at the tube walls and to document the re-sealing phenomenon were developed. Experiments with solid/solid parents were initiated.

A patent application on the liner technology was initiated by CPDL.

STATUS REPORT - SEPTEMBER 1990

A meeting was held on July 24 with McMaster, CPDL and WTC regarding the patent application for the liner. Several drafts of the application have been made and the final draft is currently being reviewed by the two inventors. The application will be filed in October.

Work proceeded on the evaluation of various liner combinations to withstand freeze-thaw conditions. In most cases the seal was disrupted after 2 cycles but the impact of this has not been determined. The tests were conducted at a very small scale and due to distortion of the containers may not be representative of field conditions. Larger container experiments (28 cm in diameter) were initiated to evaluate scale-up conditions. Excellent results were achieved with at least two of the recipes tried.

PROGRAM AREA: OTHER PROGRAM ACTIVITIES

PROJECT 66330: EXPERT SYSTEM FOR MANAGEMENT OF SEWAGE COLLECTION AND TREATMENT SYSTEMS

PROJECT MGR: T.W. CONSTABLE **TEL: (416) 336-4716**

OBJECTIVE:

To develop an integrated set of computer-based tools which would allow systematic planning and evaluation of municipal sewage collection and treatment facilities.

RELEVANCE:

Canadian municipalities are presently spending billions of dollars to maintain and upgrade sewage collection and treatment systems in response to problems of aging, environmental impairment and municipal growth. In many cases, the causes of the system problems are poorly defined and identification of the most appropriate control measure is extremely difficult. The computer-based pollution control planning system being developed in this project will allow significant cost savings to be realized through the application of a more systematic planning control process which will consider all aspects of the collection system, the treatment facility and the receiving water as an integrated system.

WORK PLAN:

1. Collect data from the City of Port Colborne for use as a case study.
2. Define the program modules incorporated within the Expert System, and specify program functions considering target user needs.
3. Develop the Expert System prototype.
4. Test the prototype using data from the Port Colborne Case Study.
5. Calibrate and validate the Expert System.
6. Prepare a report on the project and a user's guide for the Expert System.
7. Act as Scientific Authority on the contract.

STATUS REPORT - JUNE 1990

A contract was let with CH2M Hill Engineering Ltd. to develop the software. Meetings of the Technical Steering Committee for the Port Colborne Infrastructure Rehabilitation Study were held in the Regional Headquarters Building in Thorold, on May 11 and June 21. A work plan for the expert system component of the study was submitted to the committee for review, and it was agreed that a Technical Working Group for this aspect of the study should be formed.

STATUS REPORT - SEPTEMBER 1990

T. Constable attended a meeting of the Technical Steering Committee for the Port Colborne Infrastructure Rehabilitation Study on Aug. 15, and the first meeting of the Expert System Working Group for the study on Aug. 22.

B. Janik, G. Zukovs of CH2M-Hill and G. Patry of McMaster University are to meet with C. Vanderlyn of the US EPA on Oct. 12 to discuss funding for the study.

PROGRAM AREA: OTHER PROGRAM ACTIVITIES

PROJECT 68341: TECHNICAL SUPPORT: QUEBEC REGION

PROJECT MGR: M.D. WEBBER **TEL: (416) 336-4519**

OBJECTIVE:

To provide technical support to C&P Quebec Region and the MINVEQ with respect to Sludge Treatment, Utilization and Disposal.

RELEVANCE:

MINVEQ has embarked on an ambitious water pollution control program and intends spending in excess of $2 billion to install pollution abatement facilities. The Canada-Quebec agreement provides the vehicle for technology transfer.

WORK PLAN:

Provide support as required under the Canada-Quebec Agreement. Specific items identified to date include:

1. Provide technical support to Les Industries Fournier under the IRAP program to develop the rotary press for municipal sludge dewatering.
2. Provide technical support in relation to sludge utilization research and demonstration projects.
3. Support the Thetford Mines program to restore asbestos mine tailings via sludge application.

STATUS REPORT - JUNE 1990

Meetings on the development of the mobile rotary press facility for dewatering industrial sludges were held at the Centre St. Laurent on April 10 and May 15. The terms of reference for the contract and the work plan were reviewed. The criteria for the selection of the sludges were agreed to as well as the weighting factor for each criterion. The preliminary 10 sludges were identified and will be subjected to the selection criteria to generate the short list.

STATUS REPORT - September, 1990

A progress review meeting on the IRAP project was held at Granby on July 12. A summary of results on various sludges was presented and operation of the press on a physical-chemical and a digested biological sludge was demonstrated.

On September 27 a meeting was held at Les Industries Fournier in Black Lake to discuss the development of the mobile unit for the industrial press. Fabrication facilities were toured and the progress of the project was reviewed. Work is continuing on the development of the short list of sludges to be tested.

M. Webber presented a paper entitled "Des Exemples de valorisation de boues a des fins autres qu'agricoles" to the first Quebec colloquium on **La Valorisation des Boues de Stations d'Epuration Municipales,** Hull, Quebec, 18-19 September, 1990.

Also at the colloquium, guidelines entitled "La valorisation agricole des boues de stations d'epuration" were adopted as policy by the Quebec ministries of environment and agriculture.

PROGRAM AREA: OTHER PROGRAM ACTIVITIES

PROJECT 68342: **TECHNICAL SUPPORT: HAZARDOUS WASTE MANAGEMENT**

PROJECT MGR: **H.W. CAMPBELL** **TEL: (416) 336-4717**

OBJECTIVE:

Provide technical advice and support to IPB, Regions and Provincial agencies with respect to technology for hazardous waste management.

RELEVANCE:

Management of hazardous wastes in an environmentally sound manner is mandatory. Numerous site specific solutions are being sought, as are criteria for establishing acceptable technology for integrated facilities.

WORK PLAN:

1. Continue support to AR regarding remedial action at SYSCO.
2. Continue support to OWMC and MOE.
3. Interact with WMD of IPB regarding waste management technologies.
4. Participate as a member of the Working Group on Transportation of Dangerous Goods and Hazardous Wastes.

STATUS REPORT - JUNE 1990

Working Group on TDG Hazardous Wastes

A teleconference call was held with members of the Hazardous Waste Working Group on May 23 to discuss the results of the Canadian Extraction Procedure (CEP) validation study.

STATUS REPORT - SEPTEMBER 1990

T. Constable attended the Technology Transfer Seminar "Waste Disposal and Groundwater Quality Assessment Methods" sponsored by the Electric Power Research Institute (EPRI) on Aug. 7-8 in Atlanta, Georgia.

Working Group on TDG Hazardous Wastes

T. Constable participated in a meeting of the Hazardous Waste Working Group on Sept. 18-20 in Edmonton.

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